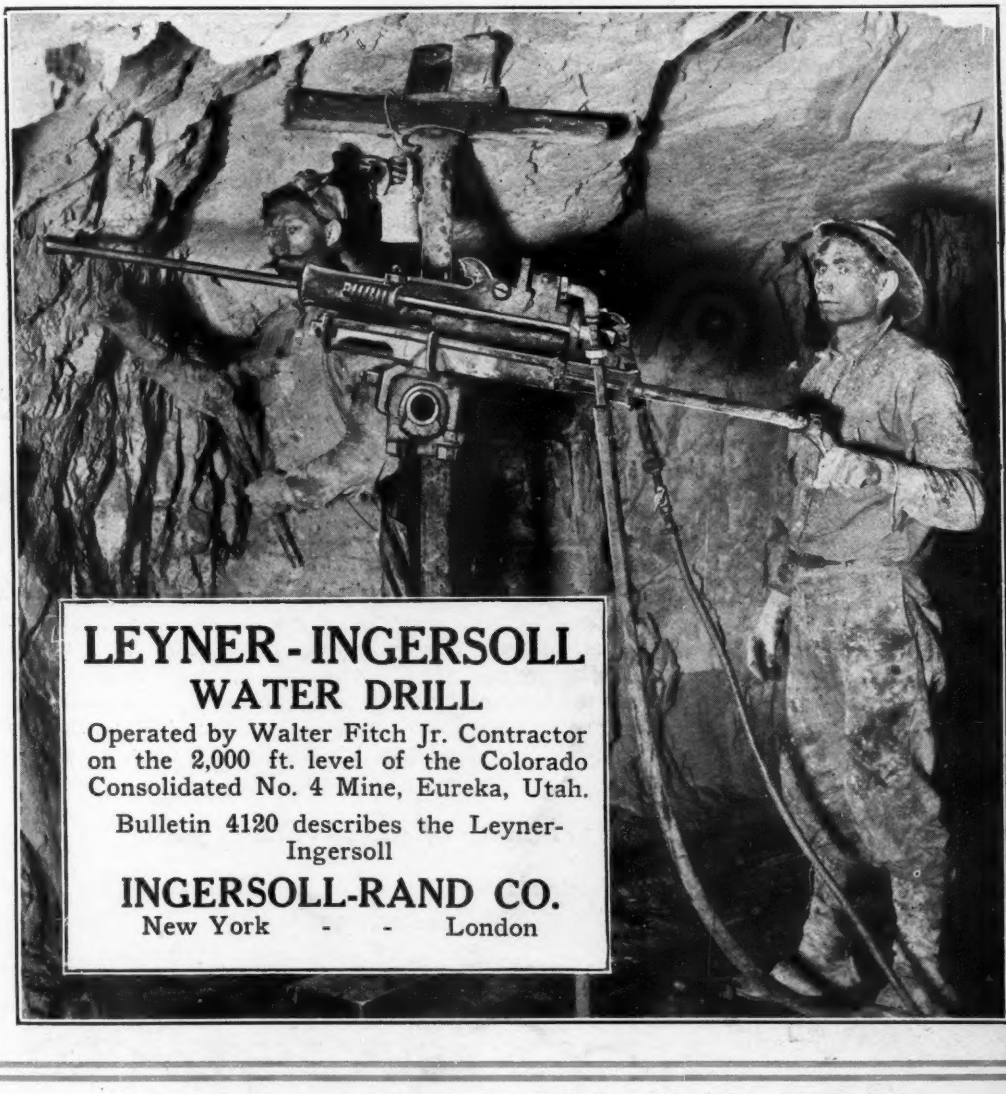
COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. xxii AUGUST, 1917 No. 8



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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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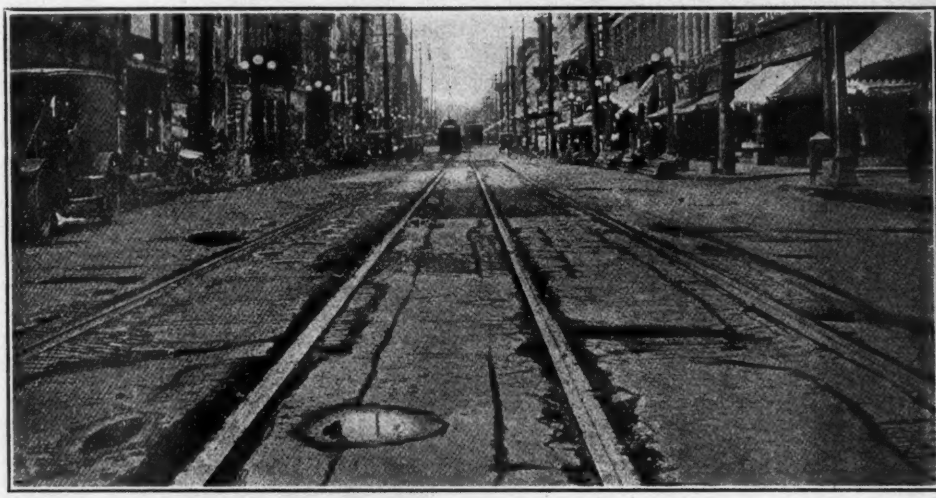


FIG. 1. STREET IN ELMIRA BEFORE REPAVING

PNEUMATIC TOOLS ON STREET RAILWAY WORK

Mr. Frederic H. Hill, General Manager Elmira (N. Y.) Water, Light and Railroad Company, in a recent issue of Electric Railway Journal, gives us an interesting account of the reconstruction of double track and street paving in two of the principal business streets of Elmira, particularly emphasizing the saving of both time and labor by the employment of modern mechanical facilities. All the cars of the city operate over the tracks to be reconstructed and vehicle traffic on the streets also is heavy, so that it was of the utmost importance to push the work with all possible speed.

The general street condition is shown in Fig. 1, the photo having been taken apparently on Sunday when the street was temporarily clear. On Lake street the work consisted in relaying about 550 ft. of double track together with a cross-over and a single-track branch-off. The old construction was 8-in. plain girder rail laid on wood ties without ballast, and the paving consisted of sheet asphalt varying in thickness from 2 in. to 3 in. laid on old Belgian block paving without sub-base.

On Water Street the work consisted of relaying about 1400 ft. of double track, a cross-over, a single-track branch-off and a double track steam railroad crossing. The paving on Water Street was of the same general character as that just described for Lake Street, with the exception that for a short distance the asphalt was laid on a concrete base. The old construction here was 7-in. plain girder rail laid on wood ties without ballast.

Before commencing work tools and material were distributed and every arrangement was made to avoid delay, although the unforeseen things, disappointments in the supply of men

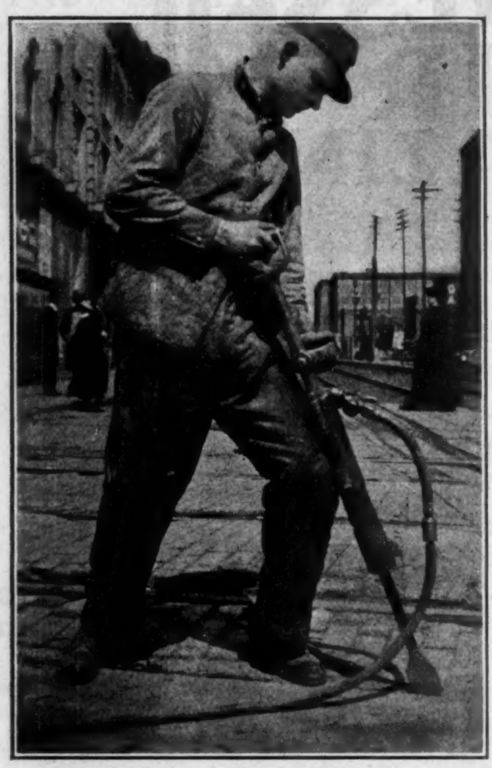


FIG. 2

and heavy rains, occurred as usual in the progress of the work.

ASPHALT CUT WITH PNEUMATIC TOOLS

The asphalt paving was first removed from between the rails and for a distance of 24 in. beyond the new line of the outer rails. For this purpose four pneumatic cutting tools were applied in a novel manner. These tools were the standard "Imperial" pneumatic tie tampers, made by the Ingersoll-Rand Company, but they were fitted with special cutting bars, made by changing the shape of the blunt bars used for tamping. This was done by forging the 3-in. by 5-8-in. face of the tamping bar down to an axe-like cutting edge. Another point of difference between the cutting and the tamping bar is that the former has a straight shank while the latter is slightly bent.

In beginning the operation of cutting the asphalt a notch or shallow groove was first cut along a chalk line drawn at the proper distance from the outer rails and parallel to them. In making this groove the operator slid the cutting edges along the pavement in front of him, guiding the tool with his knee, Fig. 2. It was found that the workman should be discouraged from guiding the tool with his foot, Fig. 3, as this method is slow and there is danger of the operator inflicting serious injuries upon himself. After cutting the groove the operator made a series of deeper cuts, leaving 8 in. to 10 in. between the cuts, the groove being depended upon to carry the break across these uncut sections. In making this deeper cut the tool was merely placed in the groove, held about vertical and rocked slightly back and forth, Fig. 4. After a few seconds the tool worked far enough into the pavement to enable it to be used as a pry bar, and an occasional prying action, Fig. 5, loosened considerable pavement.

TIME DATA ON ASPHALT CUTTING

An idea of the cutting speed of these tools can be gained from an observation made while the four tools were in operation making the outer break in the asphalt. In one hour and a half a 282 ft. cut was made, which is equivalent to 47 ft. per hour per tool

In removing the pavement between the rails

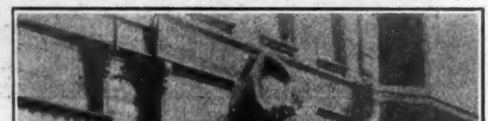


FIG. 3

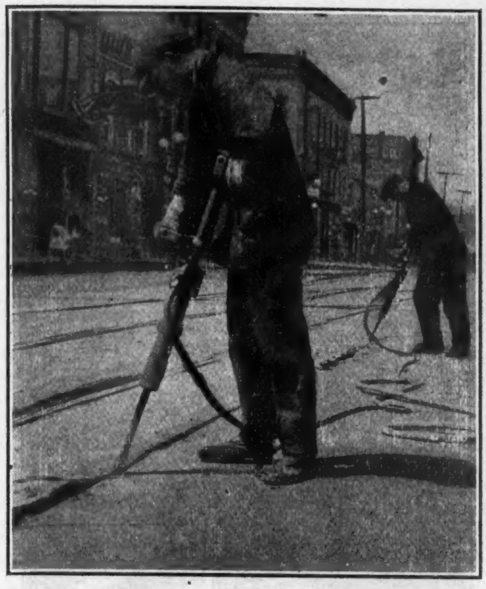


FIG. 4

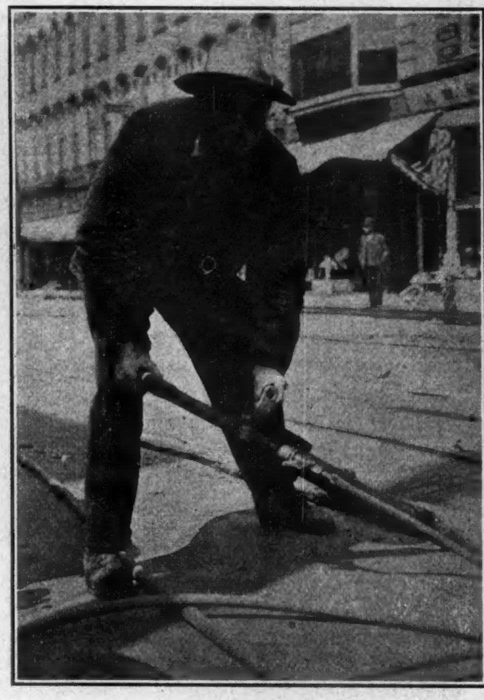


FIG. 5

advantage was taken of favorable locations for the cutting, such as along cracks and through thin spots. Good progress was also made by working the tools in pairs. The men faced each other and started the tools down inside of the rails and then pried up simultaneously, thus loosening the pavement from rail to rail. Subsequently the strips were broken into large chunks. Of course the progress in this varied greatly according to the condition of the pavement, interruptions and the like, but it is safe to say that in a shift of ten hours the average amount of pavement broken up was about 6,000 sq. ft. per hour per tool. With the aid of a pry bar the asphalt came up in

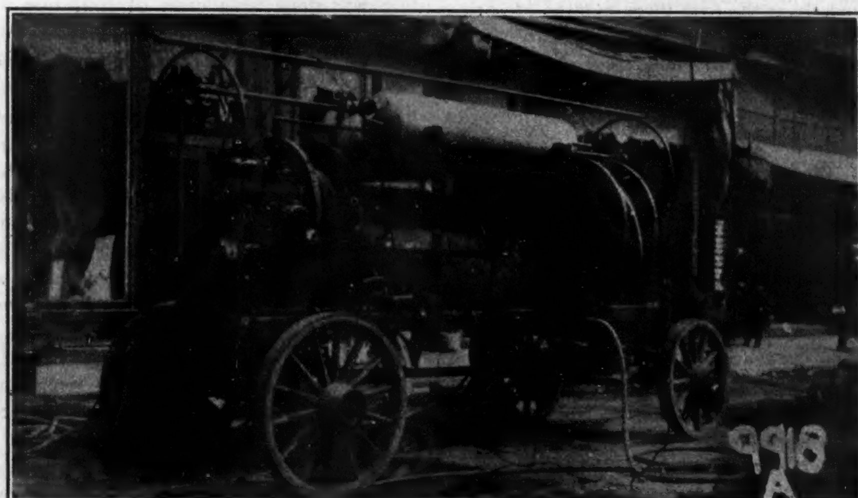


FIG. 6

long strips, which were broken up with mauls into sizes convenient for hand loading.

Where concrete occurred under the asphalt it was cut with the aid of tampers fitted with special picks. These picks were made by tapering and tamping a straight shank similar to that of the asphalt-cutting tools. The concrete was cut along the same line as the asphalt, by holding the tool vertical and rocking it slightly. By inserting the tool at intervals of about 6 in. the concrete was broken up readily. The use of the pneumatic concrete picks was relatively a greater saver of time and labor than for cutting the asphalt.

THE HOME-MADE COMPRESSOR

The normal air consumption of each pneumatic tool is rated at 16 cu. ft. of free air per minute at a pressure of 70 lb. per square inch. Air was supplied by a portable equipment mounted on a horse-drawn truck (Fig. 6). Two complete air compressor units were mounted on the truck. Each unit consisted of a direct-connected, electric-motor driven compressor of the type used on electric railway cars, an automatic governor, a receiving tank and 300 ft. of rubber hose. Each compressor had a piston displacement of 50 cu. ft. of air per minute. The hose was conveniently handled on two old wire reels, and a tool box located between the compressor provided room for tamping bars, tools, oil, etc.

It was considered advisable to adopt a double-unit compressor plant on account of its flexibility. Our large construction jobs are done mostly in the first three months of spring and summer, and after that it is a case of numerous small maintenance jobs. To handle this work it is planned to mount the compressors on work cars, so that two jobs can be carried on simultaneously. Also one unit can be used to furnish air in the shop and carhouse.

After the asphalt was broken up the rails were jacked up and removed, the nuts on the joint bolts being cut off with an oxy-acetylene blow-torch. As soon as the first pair of rails and their ties were removed a gang of shovellers began excavating for the new construction and as soon as they had cleared a sufficient space a steam shovel was put to work and carried the truck along the line. The steam shovel was followed by a 10 ton steam roller which compacted the subsoil in readiness for the ballast.

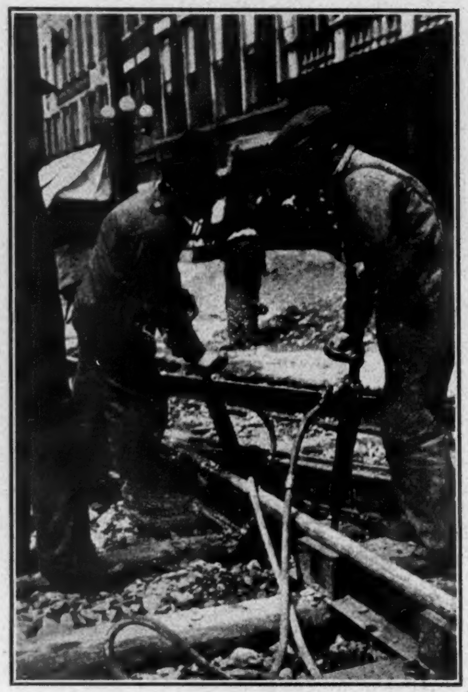


FIG. 7

After compacting the bed of the trench, oak ties 6 in. x 8 in. x 8 ft. were placed 2 ft. center to center. The new rails were 7-in. Lorain section No. 91-375. One rail of each track was roughly lined in, bolted and spiked. The other rail was then spiked to gage. The spiking was done by a crew of four men. Two, with bars, held the tie up against the rail and the other two drove the spikes with mauls.

BALLASTING WITH PNEUMATIC TAMPERS

After the spiking was completed the rails were jacked up to grade, leaving space of about 7 in. between the bottom of the ties and the sub-grade. Crushed stone ballast was then shovelled into place and tamped lightly under the ties with shovel and pick. The full length of the ties was tamped with the aid of the same pneumatic tools, which were employed for asphalt and concrete cutting. For this work standard tamping bars with 3-in. by ⅝-in. faces were used with the tools, and the men worked in pairs, one on each side of the tie, Fig. 7. By compacting the ballast from both sides simultaneously none of the force of the blows was spent in shifting the ballast from side to side. Observations made on one

section showed that four machines tamped 340 ties in twenty-six consecutive hours. The average time required for two men with the pneumatic tampers to complete the tamping operation of a single tie was from six to seven minutes.

In tamping we operated with a gang of five men. The fifth man sounded the ties and watched the grade to see that the work was properly done. He also gave the necessary attention to the compressor plant and tools. Our observations indicate that this five-man gang will do as much work as twenty-four men with picks, and the tamping is better done.

While the ties were being tamped the rails were bonded with a Lincoln bonding machine. Coover track braces placed at intervals of about 20 ft. were bolted and then welded to the rail; the welding insured the security of the brace and also improved the cross bonding. Welds were made, using a carbon pencil and scrap copper. Copper wire cross bonds were placed at the end of each section and around all special work.

SELF-PROPELLED CONCRETE MIXER

After tamping, the ballast extended halfway up the ties and the roadbed was ready for concreting. Before beginning to place the concrete Nelsonville filler blocks were first laid against the web of the rails on the inside of the track, and then the concrete was placed to cover the ties a depth of 2 in. Crushed stone and cement were distributed along the street on one side and sand on the other in estimated quantities. A self-propelled ½-yd. Ransome concrete mixer (Fig. 8) was used on the same side of the street as the stone. A gang of about thirty men were able to concrete 50 lineal feet, or about 1,000 sq. ft., per hour.

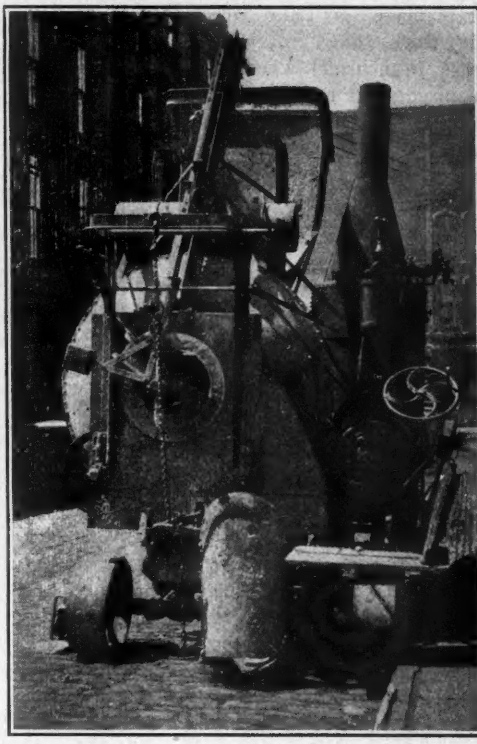


FIG. 8

The outside of the T-rails was plastered with cement mortar, and then over the concrete a 1-in. sand cushion was placed. This was rolled with a hand roller and graded, giving a final thickness of about 1 in. The bricks were then laid next to the filler on the inside of the track. A 5-ton tandem roller was used for final rolling. The spaces between the new pavement and the old asphalt were filled with grout, and pitch was used to fill cracks between bricks. A little sand was sprinkled on the brick and the street was then opened to traffic. A cross-section of the complete construction is shown in Fig. 9.

RESULTS OF USE OF PROPER EQUIPMENT

The advantages of suitable equipment and

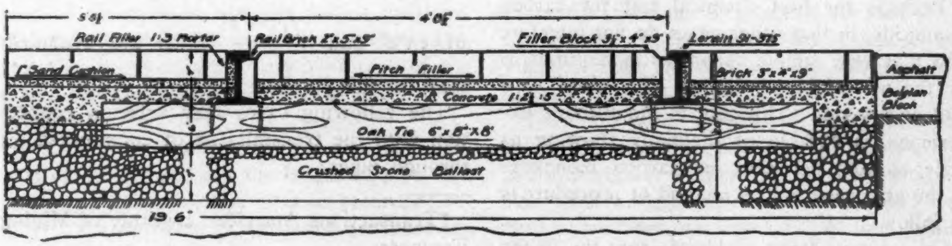


FIG. 9

organization are shown clearly by the progress made: on Lake Street (550 ft. of double track, one cross-over and one single track branch-off) where fourteen days were required, and on Water Street (1400 ft. of double track, one cross-over, one single-track branch-off and one double-track crossing) where nineteen days were required. The work was carried out by the company's own organization, augmented by laborers and gang bosses temporarily employed for the job. F. G. Maloney, superintendent of the railroad department, had direct charge of the work.

AVIATION DEVELOPMENTS.

In the course of a lecture delivered by Brigadier-General Brancker to the members of the Aeronautical Society of Great Britain some time ago, the author said the way in which war had forced a higher standard on us was remarkable. Only two and a half years ago, a pilot who flew across country at 3,500 ft. and landed without breaking anything was considered to be quite useful. Now the expert pilot has to be prepared to fly at the greatest height his machine will reach, which is sometimes about 17,000 ft., has to dive and loop and side-slip to enable him to be an efficient fighter, and has to have considerable experience in photography from the air, in the observation of artillery fire, and the transmission of the results by wireless to the ground, and in the use of the machine gun. In addition, he must be an expert bomb dropper, which needs considerable practice and experience, and finally in bombing raids, long reconnaissances, and in fighting patrols, it is necessary for aeroplanes to fly in a fixed formation in numbers from two up to twenty, an operation demanding a great deal of skill and experience in the pilot.

TEST FOR CARBON MONOXIDE

Perhaps the best chemical test for carbon monoxide, in that other gases do not interfere and that very simple apparatus is required, is by the use of blood diluted with water to a buff-yellow tint. This test, in the author's experience, is capable of distinctly showing as little as 0.03 per cent. of carbon monoxide in the atmosphere. The method of procedure is as follows:

One or two drops of blood from the finger are diluted with water until equal portions of the solutions placed in 100 c.c test tubes have a buff-yellow color; one of the tubes is taken into the mine, and at the place where the air is to be tested about 50 c.c. of the blood solution is poured out, the mine air taking its place. The tube is then corked, taken to the surface, and gently shaken for 10 min. If the air contains carbon monoxide, the pink color caused by the presence of carbon monoxide hemoglobin is detected by comparing the solution with the normal blood solution in the other tube.—*U. S. Bureau of Mines Tech. Paper* 11.

GRAPHIC SOLUTION OF COMPRESSED AIR TRANSMISSION PROBLEMS

BY C. W. CRISPELL*

The nomogram on the opposite page gives a graphic solution of D'Arcy's formula for the transmission of compressed air in pipes. This formula is:

$$D = c\sqrt{\frac{d^5(p_1 - p_2)}{w_1 l}} = \frac{c\sqrt{d^5}}{\sqrt{l}}\sqrt{\frac{(p_1 - p_2)}{w_1}}$$

where:

D = the volume of compressed air in cubic feet per minute discharged at the final pressure.

c = a coefficient varying with the diameter of the pipe, as determined by experiment.

d = actual diameter of pipe in inches.

l = length of pipe in feet.

p_1 = initial gage pressure in pounds per square inch.

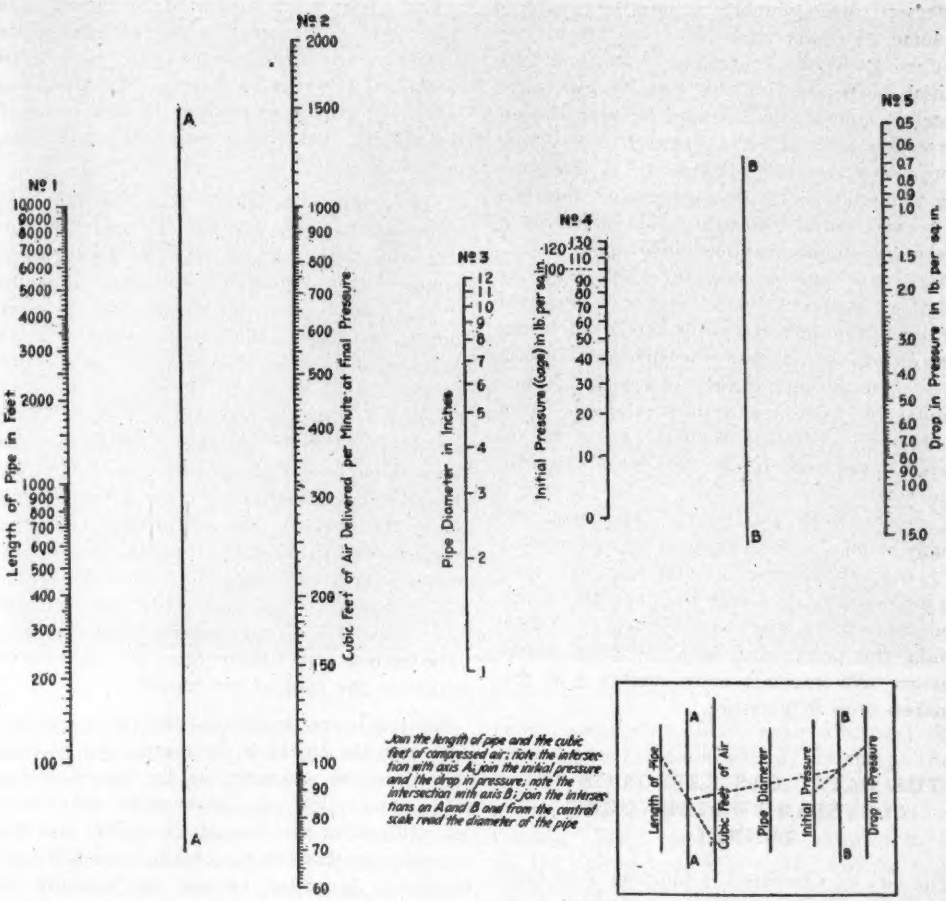
p_2 = final gage pressure in pounds per square inch.

w_1 = the density of the air, or its weight per cubic foot, at initial pressure.

The nomogram allows the solution of this equation without reference to tables for values of $c\sqrt{d^5}$ and $\sqrt{\frac{p_1 - p_2}{w_1}}$ which are ordinarily used for this purpose.

The following cases may arise in connection with the transmission of compressed air through pipes:

*Transactions American Institute of Mining Engineers.



1. Given the volume of compressed air, the length of pipe, the initial pressure, and the maximum allowable drop in pressure; required, the diameter of the pipe.

2. Given the length of pipe, the diameter of pipe, the initial pressure, and the maximum allowable drop in pressure; required, the volume of compressed air which the pipe will carry.

3. Given the diameter of the pipe, the volume of compressed air, the initial pressure, and the maximum allowable drop in pressure; required, the maximum length of pipe of the given diameter which can be used under these conditions.

4. Given the diameter of the pipe, the volume of compressed air, the length of pipe, and the maximum allowable drop in pressure; required, the pressure at which the air must enter the pipe.

5. Given the diameter of the pipe, the volume of compressed air, the length of pipe, and the initial pressure; required, the drop in pressure.

The graphic solution of each of these problems may be obtained as follows:

Case 1.—With a straight edge, join the length of pipe and the cubic feet of compressed air (not free air); note the intersection on axis *A*; join the initial pressure with the drop in pressure; note the intersection on axis *B*. A line joining the two points on *A* and B will intersect scale number 3 at the required pipe diameter.

Case 2.—With a straight edge, join the initial pressure with the drop in pressure, note the intersection on axis *B;* join the intersection on *B* with the diameter of the pipe; note the intersection on axis *A*. A line joining this point on *A* with the length of pipe will

intersect scale number 2 at the required volume of compressed air.

Case 3.—With a straight edge, join the initial pressure with the drop in pressure; note the intersection on axis *B;* join the intersection on *B* with the diameter of the pipe; note the intersection on axis *A*. A line joining this point on *A* with the given cubic feet of compressed air intersects scale number 1 at the required maximum length of pipe.

Case 4.—With a straight edge, join the length of pipe with the volume of compressed air; note the intersection on axis *A*; join the intersection on *A* with the diameter of the pipe; note the intersection on axis *B*. A line joining this point on *B* with the allowable drop in pressure intersects scale number 4 at the required initial pressure at the entrance of the pipe.

Case 5.—With a straight edge, join the length of pipe with the volume of compressed air; note the intersection on axis *A;* join the intersection on *A* with the diameter of the pipe; note the intersection on axis *B*. A line joining this point on *B* with the given initial pressure will intersect scale number 5 at the required drop in pressure.

THE FATAL GAS EXPLOSION IN CLEVELAND WATERWORKS TUNNEL*

The city of Cleveland is building a 10 foot cylindrical tunnel connecting crib No. 4, a mile out in the lake with crib No. 5 four miles further out, working from both ends. On July 24, 1916, a gas explosion at crib No. 5 end caused the death of nine men, and an hour or so later ten more men lost their lives trying to get into the working place.

Nearly every paragraph of the various State mine laws has been written as the result of such a catastrophe as that here spoken of. The mining men of this country and the Federal Bureau of Mines are trying to benefit by each explosion and each accident, putting the details on record so that similar accidents may be prevented.

*Abstract of portion of address before Cleveland Engineering Society, January 16, 1917, by W. J. German, Engineer Federal Bureau of Mines, Pittsburgh.

Fig. 1 is an interior view of the tunnel. The 6 in. pipe, mid-height, on the left carries the fresh air from the compressors on the crib down to the working force. The view was taken before the explosion, as after that all the electric lights and the wiring were removed.

Fig. 2 shows the shield, which is 12 feet 2 inches in diameter and 14 feet long, the cutting edge being shoved into the mud by hydraulic jacks. The men were working at the front of the cutting edge digging out the mud, cutting it down with knives, when a large quantity of mud was blown up in front of the cutting edges by a gas blower. When the foreman saw this he was nearly ready to shove the shield. He thought that if he shoved the large shield ahead 2 or 3 feet it would cut off the blower and prevent the gas from coming up in the tunnel. The shield closed off the gas temporarily, but it accumulated enough pressure down under the shield so that eventually it forced its way out at the tail end and again passed into the tunnel. As it was a hydrocarbon gas lighter than air, of course it rose to the roof of the tunnel.

An important mechanical device in connection with the shield is the erector for placing the successive segments of the tunnel lining in position. The gas from under the shield accumulated at the roof of the tunnel and the operator on this erector became sick and had trouble in breathing, because the pressure of the gas decreased the oxygen percentage of the atmosphere he was breathing. He came down and the foreman sent another man to take his place. The second man was overcome, but not entirely—just had trouble in breathing, and became sick. The foreman himself tried the task and also had trouble in breathing, so that he decided to leave the tunnel, and did so. The men working at the face, having trouble in breathing decided to go out. The tunnel at this time was 1,400 feet from the lock to the face. In walking back toward the lock they had to ascend to a point where the tunnel was 9 feet higher than at the face. In passing this high point the whole crew had serious trouble in breathing.

This condition was reported and the general superintendent came out next day with the crib superintendent and went down to investigate, taking some pipe fitters with them. As

FIG. 1. INTERIOR OF TUNNEL

they approached the summit they had trouble in breathing because the gas had reduced the percentage of oxygen. They drilled ¾ inch holes in the 6 inch air line at 200 foot intervals and at the summit the hole was piped leading the air to the roof of the tunnel. Passing this the men had no trouble in reaching the face. In the erector operator's box there was still difficulty in breathing. A 45 degree elbow was placed on the end of the 6 inch air line conducting the air right up into the electric motors which drove the erector.

The percentage of gas there at the time may be judged from samples taken at that point afterwards under nearly the same conditions I should judge that the gas at that time, before they put the elbow on, was far above the explosive point, so that although these men were using the electrical machinery, and undoubtedly producing sparks, no explosion occurred. They put on the 45-degree elbow and turned the fresh air up to the roof of the tunnel, stopping it from going to the face and bringing the high proportion of gas in the mixture down somewhere near the highest explosive point around 8½ or 9. After this was done, they shut down the tunnel for a day.

The general superintendent and the crib superintendent went down again the next day and experienced no trouble in breathing. They walked over the summit, went to the face, and got up into the operator's box, but they had no trouble. They came out and decided to let the shift go to work that night. On the evening of July 24 ten men went down the tunnel to start to dig out and take up the work

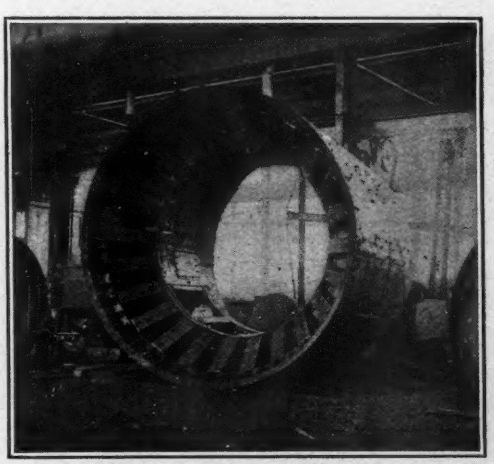


FIG. 2. THE SHIELD

that was left by the crew that was down on the night of July 22.

SOMETHING WRONG

They had been down at the face one hour when the engineer up on the crib noticed an increase in the pressure shown by the gage from 22 pounds to about 35 pounds. Seeing that there was something wrong he called the crib superintendent, who looked at the gage and then tried to talk to the men down at the face of the tunnel, but no one answered. He went down the shaft and coming to the lock he looked through the bull's-eye and saw the lock tender cleaning the debris away from the inside door in order to close it and come out. He watched him for a minute or so, then came to the top again and tried to telephone to the men at the face to send men back to help get the door closed, but he could get no answer He came back down and by this time the locktender had come out.

The locktender said: "I don't know what has happened, only that the flooring is blown up and the ties are thrown all around." The superintendent, accompanied by the locktender, went in about a hundred feet, expecting to see the regular lights in the tunnel, but they were all torn down, although the current was still on the tangled wires in the debris.

The superintendent then came out to get some flashlights. He was not affected at all by the after-damp, as seemingly it had not as yet diffused back that far. He procured some flashlights and six men to go in with him. When he got inside the lock, that is, into the tunnel, he left the locktender and one other man to take care of the lock and advanced with the other four men. After getting in about a hundred feet and looking around to see that they were following, they were all on the floor stretched out. He turned to help the man next to him and when he was in the act of getting him on his shoulder he himself was overcome and lost all control of his limbs, though still conscious but unable to call for help. His flashlight was turned toward the lock and the two men there advanced quickly and brought him back to the lock, by that time having hardly strength enough to shut the inside door and operate the valves to get out. Leaving the four men still on the tunnel floor unconscious, they went to the top and when they were in the fresh air they became unconscious and lay there for two hours before any help came. There being no telephone or other communication with the shore the crib employes sent up rockets, blew the whistle and finally attracted somebody's attention, and life-saving crews took the unconscious men ashore.

By this time the general superintendent had received word and he came out on another boat with several men, but did not see the superintendent going ashore. When the general superintendent arrived at the Crib he organized a crew of seven men besides himself and went down into the tunnel without making any inquiries. They advanced inside of the lock about 200 feet to the section where the 3-4 inch holes were bored in the 6-inch pipe. The superintendent was in the lead of the party and the other seven men were strung from the lock in. He and all his crew fell unconscious.

THE LOCKING OF THE LOCK

The lock was "in," and no one could open it from the outside because the pressure was against the outside door and unless someone was left inside to operate the valves, no one else could get in the tunnel while the pressure was on, so they lay there for about five hours before anything else was done.

At about this time the waterworks officials arrived at the crib and heard that the men had gone down and had not come back. They refused to let anyone else go down until a conference had been held. In the meantime. city firemen had arrived on the scene with some breathing apparatus and after the conference they decided to let some of the workmen go down to the air lock with the breathing apparatus on. The workmen looked in and could see some of the men in the lock lying as though dead. They came back and reported. After another conference, decision was reached to take the air pressure off the tunnel in order to get the bodies out. The only way this could be done was to break a glass bull's-eye in the lock door. The bull's-eye was 4 inches in diameter and 1 inch thick.

Breaking the bull's eye and taking the pressure off the tunnel took about four hours. After the pressure was off, the general superintendent and the man next to him revived without any assistance because they had fallen near a 3-4 inch hole in the air pipe and had been getting some fresh air. They walked

out and opened the lock door and came up. When these men came in contact with the fresh air is seemed to have some overpowering effect on them and they could not tell what had happened in the tunnel. A crew of men, some wtih apparatus and some without, went down and brought out the bodies of the rescue party, totalling ten; all were dead.

BUREAU OF MINES TAKES HOLD

About this time the Bureau of Mines rescue party, of which I was a member, arrived in charge of D. J. Parker and L. M. Jones, mining engineer. (The latter, I regret to say, has since lost his life in mine rescue work at Barracksville, W. Va.). They were making preparations to go down when they were informed that men had been in to the lock and had brought out the bodies. They then decided to make an inspection. The regular precautions that are taken at a mine were observed; that is they carried safety lamps to test for methane, and they took a canary to warn them of the presence of carbon monoxide. Their first safety lamp test at the top of the shaft showed about 5 per cent. of methane coming out of the tunnel.

The electric current was still in the wires in the tunnel and there was a light in the lock. The wires in the tunnel beyond the lock were twisted up in the debris and there was an explosive mixture of gas. This was an extremely dangerous situation, so they cut the current off on the crib before advancing into the toe of the mud. This point is 300 feet from the original face, or from the face of the tunnel at the time of the accident. When the men arrived at this point they found that the tunnel was filled with mud. The rail was marked and it was found that the mud was filling the tunnel at the rate of 4 feet per hour. They were satisfied that the men who had been caught at the face were dead, judging from the evidences of violence in the tunnel. It was decided to come out and close the lock and get the air pressure back on the tunnel. It took several hours to bring the pressure up to a point that would stop the mud from creeping in. As it was getting late the tunnel was closed for the night and the Bureau men came ashore.

The next morning H. M. Wolfin, then mine safety engineer of the Bureau, accompanied by three other Bureau men, made an inspection and found that the gas was still coming out through the top of the crib. In order to start operations it was decided that a blowing fan had better be put on the crib and an 8 inch galvanized iron pipe put down the shaft to blow fresh air into the lock. A blower man from the city came out and started to put down the pipe. It was a very dangerous job for a man who was not used to working in gas. He installed the pipe from the crib to the lock and an engine and fan was erected on the crib and put in operation about midnight. The next morning the air in the shaft was nearly free from gas and the men could detect only about 3 per cent. of gas down at the lock, but it was still blowing out through the lock door. When they went inside the lock the gas at the roof was far above the explosive point.

The crew advanced into the tunnel 1,200 feet and in looking around they found that the 6-inch air line that went to the face was broken at the toe of the mud. The break was due to the force of the explosion. The chief electrician was down with the crew at this time and he noticed an outward pressure. The pressure on the tunnel was 30 pounds, but still there was an outward pressure from the 6-inch line. The Bureau men took a sample of the gaseous mixture that was coming from the pipe and it showed 60 per cent. methane. It was decided that the gas in the tunnel was coming from this break. They contemplated using one of the 2-inch pipes, shown in Fig. 1, that was used for a waterline before the explosion, and the necessary connection was made to join the 2-inch line to the 6-inch line. They disconnected the 2-inch line from the water pump on the crib and extended it out through the roof of the crib and let it discharge to the atmosphere. The pressure was greater than 30 pounds and the gas roared out on top of the crib. Samples were taken from this pipe every day for several weeks and none showed less than 30 per cent. methane. You can see the situation. The gas blower and the shield were in the face and 300 feet of mud behind it. The gas came from beneath the shield. The mud that filled the tunnel did not come from the face, but it came through the holes in the roof. The block lining of the tunnel was badly damaged and ten holes were blown in the roof. Twenty of the blocks that were blown out have never been accounted for. They were probably blown up into the mud at the bottom of the lake. The

men in charge placed timber across these holes and put in brick and built arches.

You can understand the circuit of gas. It was feeding into the 8-foot space at the front end of the mud and passing into the 6-inch line and out into that part of the tunnel extending from the toe of the mud to the lock. The mud acted as a seal and the gas escaped only through the pipe to the surface so that 22 hours afterwards the tunnel was free from gas.

The tunnel officials then went ahead to clean out the mud. Of course, the track had to be relaid, as it had been blown out. New flooring was put down and the work of clearing out the mud was started. The holes in the roof were timbered first. The mud was cleared 8 feet in advance of a hole which was then bricked up, because the mud was very soft and would force its way into the tunnel. Between two of the timbers there was a half inch space through which, in spite of the 30 pound pressure, the mud came like a sheet of steel in the rolling mill and coiled up on the floor. The men were not allowed to advance too far until the holes were bricked up. Advance was made in this way until the men arrived at a point 100 feet from the toe of the mud. There, two bodies were found under blocks. The legs had been blown off one man and each man's neck was broken and each had been burned severely. After the work of advancing had proceeded about three or four weeks more, as near as I remember, the rest of the bodies were recovered at the face. They were in an awful condition. All had been burned and had suffered broken necks and backs.

After all the mud had been cleared out, the seal on the gas was gone, so that the gas no longer passed through the 2-inch pipe, but came into the tunnel. The day after all the bodies had been recovered, the tunnel was filled with gas and the conditions were just as dangerous as the day after the explosion. However, the bodies were out, and the Bureau officials were satisfied to take a little time to devise some scheme for removing the gas.

The slab forging for the crankshaft of a 125-horsepower airplane engine weights 605 lb. The finished shaft weighs 46 lb. The forging, of chrome-vanadium steel, costs over $200.00.—*The Gas Engine.*

A PNEUMATIC CONCENTRATOR AND AMALGAMATOR

BY FRANK A. STANLEY

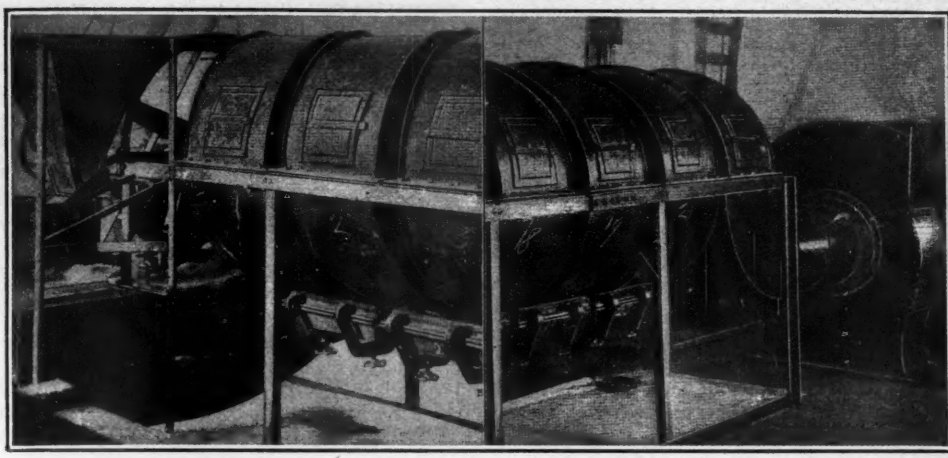
The illustrations show a pneumatic concentrator and amalgamator consisting of a vertical conduit in which a circular air current is produced by an exhaust fan at the conduit terminal, the speed of the air current being varied as desired to suit the fineness of the gold to be amalgamated.

The material, which is finely pulverized in order to entirely free the gold, is fed at the intake in predetermined quantity, at a rate so that the air current will carry it in suspension in the form of a cloud throughout the whole length of the conduit. Mercury-charged eddying chambers are attached outside the path of the circular air current along the bottom of the conduit opposite each complete circle; and a set of revolving agitators are operated in each of these chambers to assist amalgamation.

The centrifugal force imparted to the finely pulverized material by the circular air current causes the heaviest material to crowd closest to the outer wall of the conduit and to leave its helical path on reaching the openings to the eddying chambers—the heaviest gold first and the finer gold later on as it acquires accelerated centrifugal force and the full speed of the circular air current.

The design of the apparatus will be understood by reference to the illustrations, the first showing the feeding and the last the discharging arrangements. The exhaust fan is connected with the discharge end, which produces the circular air current for carrying the material through the apparatus. These views show the series of mercury-charged vessels along the bottom of the amalgamator in which the gold is amalgamated.

The line drawing shows important features of construction. To the lower part of lower sections are attached the amalgam chambers. Each section is so formed that two of them complete one turn, or winding. In the machine illustrated there are 20 windings and a total length of air passage of 210 ft. The cross-section of the conduit is rectangular in form, and the sections are constructed of sheet metal with flange and bolt connections along the horizontal center line. This enables a conduit of any desired length to be built up or readily taken apart.



FEED END DISCHARGE END

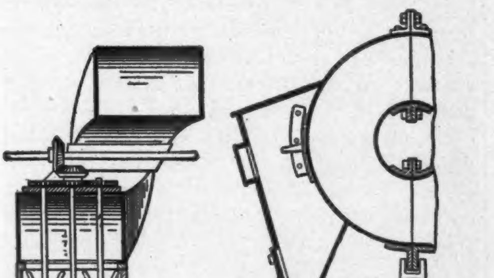
The intake is in reality a horizontal extension of the first section of the conduit, and here the air is taken in to be drawn through the entire conduit with a speed dependent upon the nature of the material. The ground ore is introduced through a branch pipe over the mouth of which is placed a sieve, while directly above this sieve there is a hopper with a loose bottom, which is regulated to control the quantity to be fed. By means of the sieve the material is agitated and delivered into the conduit in a finely divided condition. Motion is imparted to the hopper bottom in the sieve by means of a camshaft which agitates the sieve, which in turn actuates the hopper bottom.

The amalgam chambers extend across the entire width of the conduit, and perpendicular to each chamber there is a series of agitators calculated to facilitate amalgamation. These agitators are driven by spur-and-bevel gearing by a central shaft, an arrangement that simultaneously drives all the agiators in all the chambers. Each of the agitators is provided with projecting fingers which extend to the top of the amalgam chamber. The vessels may be removed, emptied and recharged with mercury.

It will be seen that there are few moving parts to break down or wear out. Instead of centrifugal force being imparted to the material, this force is created by the air current produced by the suction of the exhaust fan; so that the material, instead of traveling where it is pushed, is in reality drawn through by suction and follows the current. The particles of material are therefore free to change their relative positions in the current under the influence of centrifugal action.

With this air current produced by suction the barometric pressure is different at every point and increases gradually from center to circumference and is at all points lower than the external atmospheric pressure. These conditions greatly facilitate the separation of the gold by centrifugal force.

The material must be pulverized to a state of fineness so that the coarsest particle of gangue will not be heavier than the finest particle of gold to be separated. The pulverizing should be done by impact crushing, so that the gold, being malleable, will flatten, while the gangue will pulverize. A particle of gold and a particle of gangue each passing 150-mesh would be easily separated because the gold will



SKETCH OF DETAILS

be about eight times heavier than the gangue. In the same proportion any particle of gold up to eight times smaller than 150-mesh—that is, up to 1,200 to the inch—will be collected in the eddying chambers and amalgamated. The agitators in the eddying chambers are intended to agitate the concentrates in order to bring the gold into intimate contact with the mercury which is below the concentrates and entirely away from the path of the circular air current.

Gold recovery is practically uniform when once the machine is regulated for the particular material. If the gold is coarse, a 15 ton amalgamator may be speeded up to 20 tons per day, and if the gold is fine the speed may have to be reduced to 12 tons a day. If there is any gold left in the tailings, the speed of the machine should be reduced until the exact point is reached when all the gold is recovered.

Actual results obtained with this machine show from 95 to practically 100 per cent. of the gold can be recovered. The following test data are characteristic of numerous runs:

	First Run %	Second Run %
First five amalgam pans......	98.400	89.900
Second five amalgam pans....	.940	6.480
Third five amalgam pans.....	.005	2.210
Fourth five amalgam pans....	.004	1.200
	99.349	99.790

A pneumatic concentrator may be constructed on pratcically the same principle as the machine already described.

The concentrates are collected in side-compartments provided, from which they are discharged automatically through the channel by way of the counterbalanced gates, which in consequence of the suction are held closed until the weight of the accumulated concentrates overcomes the suction, when the gates open to discharge the material and then automatically close. By means of side openings countercurrents may be effected, and in this way the discharge of the concentrate can be regulated.

The machines illustrated and described are the development of C. T. Heisel, 4 St. Clair avenue, Cleveland, Ohio, and are in practical operation in Reno, Nevada.—*Eng. and Min. Journal.*

The land occupied by the right-of-way of American railroads has an area of more than 5,000 square miles, much of which is capable of crop growing.

PNEUMATIC CONCRETE MIXING AND CONVEYING IN NEW YORK SUBWAYS

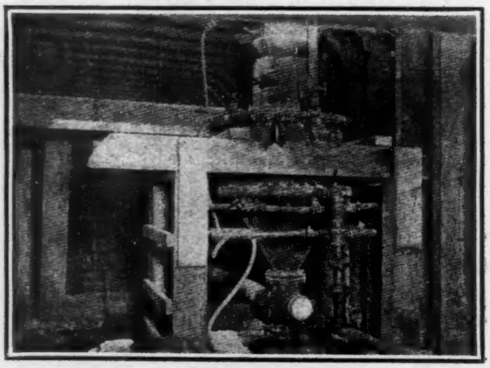
The Whitehall St. subway station at the lower end of Manhattan Island, New York, is built in a tunnel excavation 50 ft. wide and 600 ft. long quarried out of solid rock under a busy street carrying a heavy traffic. The concrete required for the roof, walls, and floor was mixed and deposited in the forms without the use of elaborate plant and without obstructing the very limited underground space or interfering with other construction operations in progress there.

The results obtained are equivalent to those that can be secured when it is possible to mix the concrete on the surface and chute it down directly to required position in the forms in an uninterrupted stream which with ordinary plant would mean a complicated, movable installation and a considerable obstruction of the street or tunnel.

METHOD OF MIXING AND HANDLING

A Ransome-Canniff pneumatic mixer and placer was installed in a convenient part of the excavation at Stone and Whitehall St. where the space it occupied was not required for other purposes.

The type A machine of improved construction was set so that the 8-in. discharge pipe was about at roof elevation and so that the



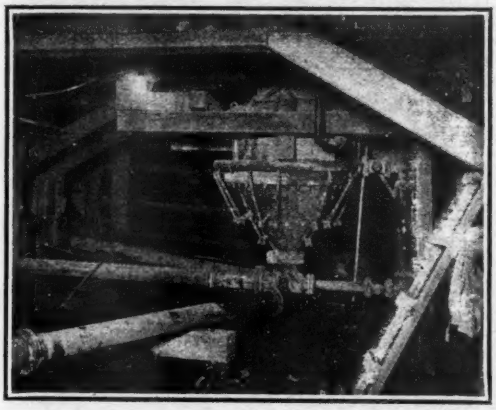
I. TYPE A MACHINE IN EXCAVATION

charging hopper could be filled with ready-mixed gravel or subway aggregate dumped in the street above and delivered by gravity through a chute about 20 ft. long. Bags of cement were also chuted down from the street to the charging platform so that the required quantities of material for one batch of concrete could quickly be placed in the machine

by operating the control levers and the mixing and conveying rapidly accomplished by the manipulation of the pressure valves.

The 8-in. flanged cast iron discharge pipe was carried along the tunnel roof out of the way of material cars and delivered ½-yd. batches a distance of 150 ft. including three standard 45 degrees bends, at an average rate of one batch every 55 sec., discharging it against baffle boards that promoted equal distribution on each side of the form where it was well spaded.

The rapidity and smoothness of the operations were accentuated by the notable absence of concrete cars and the long incline by which such cars are usually pulled up to a sufficient height for dumping into the forms.



2. PNEUMATIC MIXER AND CONVEYOR

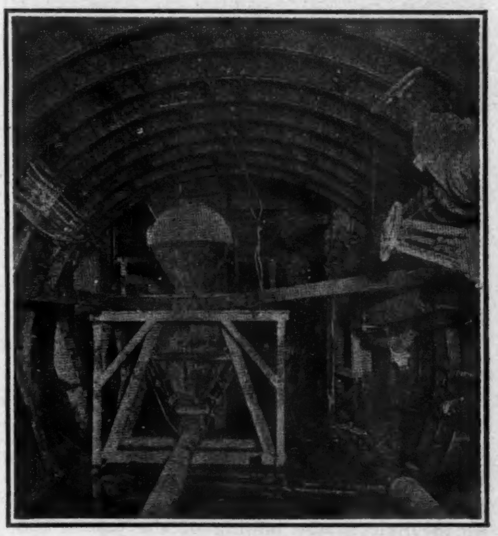
OPERATION OF PNEUMATIC MACHINE

The machine is of the latest improved type with a conical cast iron case set with the axis vertical. Midway between the top and bottom it is enclosed by a 3-in. water pressure manifold pipe supplying ¾-in. jets that discharge into the interior of the machine at two levels. Aggregate and cement are delivered through a pipe from the charging hopper to the machine and are agitated by water under pressure forced in through the manifold and its jets. When the empty upper part of the case is filled and the pressure has become equalized, the agitation ceases, the booster valve in the 3-in. air pressure pipe is opened, and the mixed concrete is driven through the discharge pipe, leaving the mixing machine ready for another batch which it receives as soon as the booster valve is closed and the charging valve opened. As long as the pressure and supply are maintained and the quantities accurately measured, the mixing and conveying goes on uninterruptedly at a rapid rate.

Part of the concrete was made with gravel of different sizes up to 2-in. and part of it was made with broken stone from ¾-in. to 1½-in. and eventually with broken stone all ¾-in. size. It was mixed and conveyed with air at 90 lb. gage pressure and it was found that the gravel concrete required less air for conveying and produced practically no wear on the pipe or the pipe bends, but that the crushed stone wore the bends materially, making it necessary to reinforce them on the outside with 3 to 5 in. of concrete.

CIRCULAR TUNNELS AND SHIELD DRIVEN TUNNELS

Pneumatic machines of the same make have been installed for the concrete lining of the subway tunnel at Flatbush avenue and Willoughby street, Brooklyn, and will be used for lining the two subway tunnels under the East River that have been driven by the same contractor. The river tunnels have cast iron tubes made of the usual segmental pieces 26 in. long connected together by bolts through interior flanges on all sides. The projection of these interior flanges from the web plates of the segments retards the flow of the concrete when placed by ordinary methods but will not prevent the concrete from being forced into all of the spaces by the pneumatic placing method which will thus obviate the necessity of filling each segment separately.

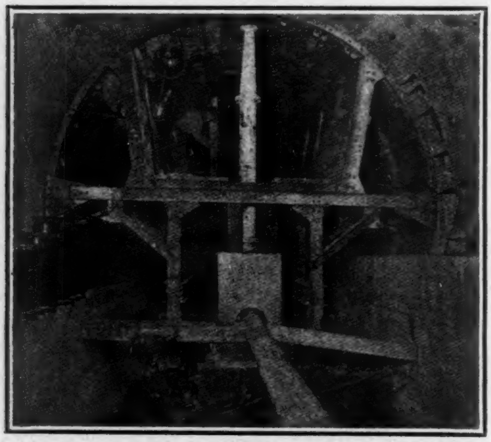


3. PNEUMATIC MIXER IN TUNNEL

At Flatbush avenue and Willoughby street the cylindrical tunnel has a permanent lining of segmental cast plates like that used for the river section, that is assembled under the tail of the excavating shield. The entire inner surface of the lining is protected with concrete forming a heavy invert and duct benches continuous with the thinner arch shell extending down below the springing line on both sides.

This thin shell is deposited by the pneumatic placing machine in the narrow space between the segmental lining and a movable, collapsible steel arch form mounted on a steel tower with an overhead working platform and clearance underneath for material cars.

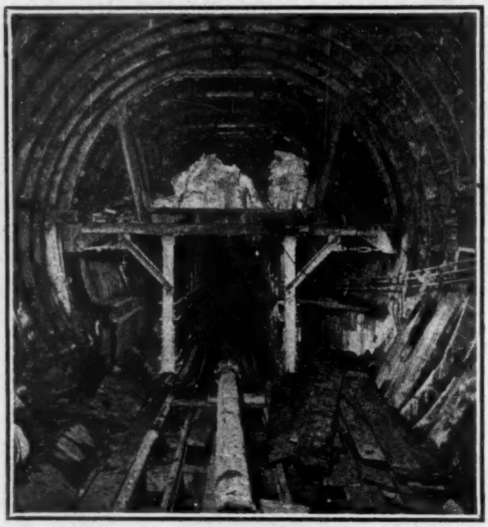
The discharge pipe from the concrete mixer is laid on the invert between the track rails and at the forward end it is thoroughly braced to prevent any lateral displacement at the 45° bend that connects with a vertical section terminating in a reducer which passes through the steel form at the crown and discharges the concrete in the required position.



4. DISCHARGE PIPE WITH VERTICAL REDUCER

The end of the discharge pipe was closed by a plug inserted in the pipe and secured there by cross bolts passing through the pipe. This plug received the impact of the concrete and absorbing its velocity caused the latter to drop through a large, horizontal hole cut in the bottom of the pipe.

The pipe extended through the end of a horizontal wooden box parallel with the pipe and penetrated the box to a point beyond the end of the hole in the bottom of the pipe. The concrete therefore flowed smoothly from the bottom of the pipe into the box and distributed through the box from which it was discharged into the space behind the wall columns. The box, 12 in. wide and 12 in. deep on the front side, was 18 in. deep on the rear side, with the bottom inclined downward toward the wall of the tunnel, and with the vertical wall of the tunnel side reaching only from the top of the box to within 6 in. of the bottom, thus leaving an open space through which the concrete flowed readily into the forms.



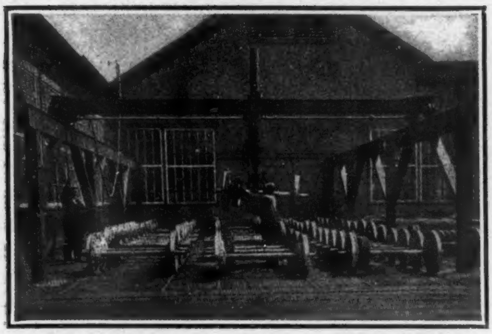
5. CONCRETE PIPE BETWEEN RAILS

AIR AND POWER REQUIRED

The amount of air required for mixing and placing the concrete varies with the length and diameter of the discharge pipe, but not in exact proportion to its dimensions, because there is a maximum demand required for the initial displacement. For conveying the ½ yard batches up to 750 ft., about 950 cu. ft. of free air per minute will suffice if compressed by a machine having a capacity to maintain a pressure of 90 lb. per sq. in.

The cost of the power can be estimated from a computation of the electricity required to operate a 150 h.p. motor that will drive an air compressor of 950 cu. ft. capacity. This motor should not consume more than 600 kw. of current in one 8 hr. shift.

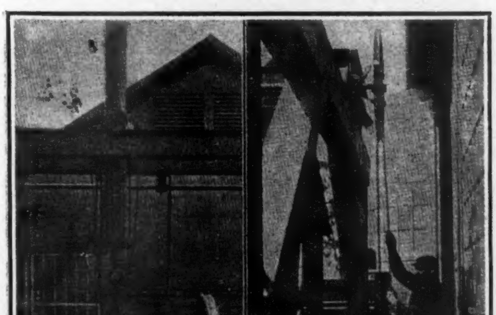
The work described was designed and executed under the direction of the Public Service Commission, Robert Ridgway engineer of subways. The Flinn-O'Rourke Co., Inc., is the contractor.—*Contracting*, June, 1917.



PNEUMATIC HOIST ON TRAVELING BEAM

PNEUMATIC TRAVELING HOIST IN WHEEL YARD

To increase the storage capacity of its wheel yard and to save time in placing or removing wheels, George St. Pierre, superintendent of equipment San Francisco-Oakland Terminal Railways, devised the hoistway shown in the accompanying illustrations. The wheel storage, which is three tracks wide and about eighteen wheel sets deep, is flanked by beam trestles which carry a 70-lb, rail for the hoist carriage. This carriage is mounted on four 12-in. double-flange wheels, one of which is connected to a 36-in. power transmission wheel. The hand operation of this wheel by a chain causes the easy movement of the carriage. The home-made air hoist has a 6-in. piston and a lifting capacity of 4,000 lb. A man can easily handle a wheel set in a minute or two with this device.—*Electric Railway Journal.*



OPERATING THE TRAVELER

DANGERS OF THE METRIC SYSTEM

At a recent meeting of the Institution of Mining and Metallurgy in London, Mr. W. R. Ingalls, Editor of the Engineering and Mining Journal, President of the Mining and Metallurgical Society of America and also President of the American Society of Weights and Measures, submitted a paper entitled "Shall Great Britain and the United States adopt the Metric System?"

The writer expressed the hope to help to open the eyes of the members to a great danger with which both Great Britain and the States were threatened by the present strong metric propaganda. The subject was of vastly greater importance than was commonly comprehended and the people of Great Britain, her colonies and the United States should be roused to the importance of preserving their interests.

SHARP LINE BETWEEN DECIMALS AND THE METRIC SYSTEM

The advantages of the decimal system are so manifest in many cases that the pro-metric party is wont to cloud the issue by making it appear as if the metric system were the only decimal system. Really, there is the fundamental difference that the decimal system per se is merely arithmetic, while the metric system involves the basic units of weights and measures. Another source of confusion will be dispelled if we can eradicate the chimerical idea of establishing uniformity. From a project that would manifestly put the weights and measures of the greatest industrial nations of the world at sixes and sevens it must be evident that the result would be more discord instead of more uniformity. The substitution of metric weights for English weights would create relatively little disturbance. Of course, the changing of all our weighing scales would cost a huge sum, and the recalculation of schedules—such as railway rates—might come to something like the ransom of an empire, but after these were done, we might get on pretty well.

THE METRE IN RAILROADING

Let us consider the conditions that have been established in the railway business. The tracks are marked with mile posts. The railway gauge is 4 ft. 8 1-2 in. We might in course of time get in the habit of thinking of the latter as 1,435 mm., but manifestly it would never be convenient to refer to the mile posts

as being 1.60935 km. apart, and either we should have to continue to think of miles, or else pull up the posts and replant them at km. intervals, which would be something of a job. Incidentally, our posting of highways would have to be revised, and the automobilist would mourn the day when metric legislation was enacted.

THE METRE IN THE MACHINE SHOP

In machine shops the measures would be done with the aid of standard gages, conforming to the requirements of practice and convention. These gages are based on the inch. If the metric system were made compulsory, it is obvious that there would be but two alternatives, viz., to restamp the gages with strange and unhandy figures, and wait until people became accustomed to them as, for example, to ask for a 6.35 mm. rod when they wanted a 1-4 in. rod; or else to change the standards so as to make them conform to metric units. Either horn of the dilemma is bad, but the second one—the changing of gages—would be calamitous. Some large American manufacturers have estimated that such a change would cost them individually from $500,000 to $750,000. So it is with all our affairs. Our entire system of manufacturing, of building and of doing things is based on standard units, which cannot be changed except under conditions that would mean nothing less than calamity.

THE METRE IN THE BUILDING TRADES

Does anybody imagine that a 2x4-in. joist could be anything else but a 2x4, although it might be called a 50.8x101.6 mm.; and after we were given specifications in metric measures, should we not have to translate them back into English measures, in order to make use of our tables of board measure for easy computation? Of course, we all know that a 2x4 is seldom of those exact dimensions, and we should probably call it a 50x100 mm. after we had learned the rules of the new game. But sometimes it is necessary to figure closely in connection with joists S4S, and then we know that the 2x4 is reduced to 1¾x3¾ in. How we should conveniently arrive at the exact dimensions of a nominal 50x100 mm. joist deponent sayeth not.

Any change of standards in either metric or non-metric countries is preposterous, unthinkable. We have all gone too far. Besides the colossal expense of substituting gauges the result could not be anything but a mixture. The man who needed some ½-in. bolts for the repair of his automobile would not relish the information that they were no longer made, but that he could have 10 mm. or 15 mm. bolts.

NON-METRIC TABLES

We have volumes of tables of figures devoted to the properties of structural steel. Similarly as to mechanics, hydraulics, surveying, in brief all the branches of engineering. With the metric system these would be all but useless. The compulsory adoption of the metric system would be no less preposterous than an edict that after a certain date all business in the United States—all buying and selling, all engineering, all figures—would be illegal unless done in French.

"ONLY"

The prime argument advanced for the metric system is to have international uniformity. It is stated that a long list of the countries of the world have adopted the metric system, *only* the United States, Great Britain and her *Colonies*, and Russia (of the Indo-European nations) having failed to do so. I have italicised the words *only* and *Colonies*, for therein is concealed the speciousness of this argument. If with "Colonies" we equate Canada, Australia, New Zealand, Tasmania and South Africa, we have a longer list of non-metric countries, and it comprises not only the most populous, but also the most industrial nations of the world. A correct statement of this theorem would be: Considering the Indo-European race alone, there is a much larger population that does not use the metric system than does; and their nations are far superior in industrial development, measured by iron production, let us say, to all other nations combined. The foisting of the metric system upon them would be, therefore, like letting the tail wag the dog.

THE METRE OPPOSED TO UNIFORMITY

If uniformity be the objective, it would be better to institute a propaganda to induce Germany, France and the Latin countries to adopt the English system. In this connection it may be remarked that, although Russia has a system different from either, the fundamental Russian measure of length, which is the most important of all measurese, is the foot, and the Russian foot is the same as the English.

Another argument on the ground of uniformity relates to the confusion existing in the English system owing to the different

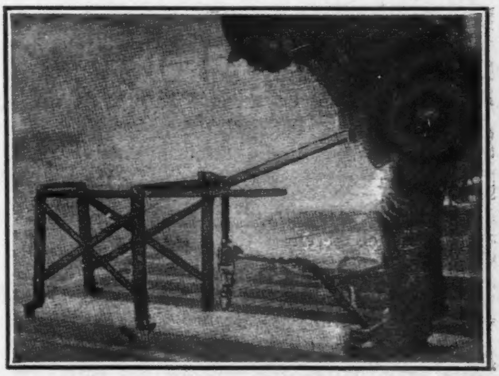
kinds of tons, pounds, gallons, etc. That there is such confusion, with its inherent dangers, is true; but it is also true that the confusion is much less now than it was twenty years ago, that it is bound to experience further reduction, and that it may be eliminated entirely in a way far easier than by the introduction of the metric system. In Great Britain there is but one kind of ton, viz., that of 2,240 lbs. In the United States the English, or long ton, is employed to far less extent than formerly, and in the main we have standardized the ton of 2,000 lbs. That we should have two pounds—the avoirdupois and the troy—is annoying, but the annoyance is now more academic than practical, for the troy pound is seldom used. Similarly have the differences among gallons, bushels, etc., lapsed in the main into innocuous desuetude. But with respect to confusion, the skirts of the metric system are not clean. As a statistician of nearly thirty years' experience I may say that I have fallen into more errors over the zentners and doppel-zentners of metric Germany, and the quintals and metric-quintals of Chile, than I have over the pounds of England and America and the poods of Russia.

The third metric argument is the ease of the calculations, especially the correlation among measures of length, volume and weight. It may freely be admitted that there is some merit in this, but the English system is not quite helpless in this respect; and the superior merit of the metric system is far short of being a determining factor, quite apart from its calamitous effect in overthrowing existing standards and upsetting the mode of thought of the people, which of course are the major considerations.

In concluding his paper the author emphasizes the point that his arguments are not directed against the metric system, but rather against the propaganda for the *compulsory* adoption of it.

COMMERCIAL AERONAUTICS

At a recent meeting of the Aeronautical Society of Great Britain a paper on "Commercial Aeronautics" was read by G. Holt Thomas, one of the pioneers of aviation in that country. Mr. Thomas said that in his opinion aeronautics would revolutionize the world not only from a commercial point, but also from a humanitarian point much more than it had revolutionized war. He said he was not one of those who thought commercial aeronautics were going to beat out of existence the railroads and other forms of transport, but rather that flying would act as an adjunct to present modes. From a business point of view speed was everything. The airplain would enable a business man to leave London in the morning, go to business in Paris and be home again to dinner. It would take him to Bagdad in a day and a half or to New York in two days. Ceylon would become 2¾ days from London, Tokio 4½, Sydney five, Cape Town 3½, and Vancouver 3. As for the question of cost it would be possible to run a profitable air service between London and Paris at $25 a passenger, a cent an ounce for mails and 50 cents each for parcels of three pounds. A Constantinople or Moscow journey of twenty-four hours might involve a cost of $125 a ticket.



PNEUMATIC DRILL MOUNTING FOR LARGE SHEETS

To avoid the trouble and expense of handling long steel sheets over a drill press, a pneumatic drill supported by a home-made carriage is used in our shops as shown in the photo. The carriage has a very wide range over which to operate, being arranged to slide lengthways of the sheets while the drill itself can be moved back and forth across the sheets. There is a lever by which hand pressure is exerted on the drill, and when this pressure is released a coiled spring raises the drill out of the work and it is ready for the next hole. This device allows the sheets to lie flat at all times, and, as it can be operated by one man, it saves a great deal of the labor in handling the long sheets.—*G. B. Sisson in Electric Railway Journal.*

THEORETICAL AND ACTUAL AIR DELIVERY OF COMPRESSORS

BY ROBERT S. LEWIS

Air compressors are rated by their manufacturers on the basis of piston displacement, or volume swept through by the piston, expressed in cubic feet of free air (air as it may be under the local atmospheric conditions of pressure and temperature) per minute. If compressors delivered this quantity of free air as compressed air such a rating would be correct; but various factors modify the intake capacity of a compressor, so that it may be much less than the piston displacement. The ratio of the free air taken into the compressor, stroke after stroke, to the piston displacement is called the volumetric efficiency of the machine, and may be expressed as an equation:

$$(1)\quad Ev = \frac{\textit{cu. ft. of free air taken into cylinder}}{\textit{piston displacement in cu. ft.}}$$

The important factors which modify volumetric efficiency are clearance, volume of piston rod, heating of the air before compression, leakage of air past the piston and also leakage of intake and discharge valves, too small area of valves and mis-timed operation of mechanically controlled valves.

The space between the piston when at the end of its stroke and the cylinder head is filled with compressed air which cannot be expelled. During the return stroke this air must expand until it is at atmospheric pressure again before any free air can enter the cylinder. If this clearance space is large the free air intake capacity of the cylinders is materially reduced. In well-designed single stage compressors the clearance, expressed as a per centage of the displacement per stroke, may be as low as 1 per cent. for the large sizes and 2 per cent. or more in other cases. This means that for a low clearance value the distance between piston and cylinder head at the end of the stroke may be only $^1/_{16}$ or even $^1/_{20}$ in. The effect of this clearance increases as the ratio of compression (final absolute pressure to initial absolute pressure) increases.

For large clearance ratios the piston must travel a considerable part of its stroke, while the air is re-expanding, before any free air can enter the cylinder. If it were possible to compress to 5000 lb. per sq. in. in a single cylinder of ordinary design no air at all would be taken in during the return stroke, the air in the clearance space expanding to entirely fill the cylinder.

Assuming here for convenience that this clearance air expands isothermally, which may be nearly as correct as to consider that it expands adiabatically, the effect of clearance may be calculated as follows:

Let Ec=volumetric efficiency depending upon clearance.

C=clearance expressed as a decimal.

r=ratio of compression$=\frac{P}{Pa}$, P being final absolute pressure in lb. per sq. in., and Pa being the initial absolute pressure. (Absolute pressure is gage pressure plus atmospheric pressure).

(2) Then $Ec = 1 + C\ (1 - r)$.

Thus, when compressing from an atmospheric pressure of 14.7 lb. to 100 lb. gage with a clearance of 2 per cent. we have:

$$r = \frac{100+14.7}{14.7} = 7.8 \text{ and } Ec = 1+0.02\ (-6.8) = .864, \text{ or } 86.4 \text{ per cent.}$$

In case the clearance of a compressor is not known, it may often be determined, as is done with steam cylinders, by measuring the volume of water required to fill the clearance space.

The effect of clearance upon volumetric efficiency is lessened by using two stage compression. Since the air is not compressed to the final pressure in a single cylinder, the percentage of the volume of the low pressure cylinder occupied by the expanded clearance air is reduced. The piston rod occupies space on one side of the piston, consequently the displacement per revolution, or double stroke, corrected for clearance, less the volume of the piston rod, will give the free air intake capacity of the compressor per revolution.

Under constant pressure, the volume of a given weight or quantity of air is proportional to its absolute temperature (460F.+thermometer reading). At 60 deg. F. a given volume of air will expand $^1/_{520}$th of its volume at this temperature for each degree, Fahrenheit, of rise in temperature. If one cubic foot of air at 60 deg. is heated to 100 deg. as it enters the compressor its volume will be increased

$^{40}/_{520}$ths, or approximately 8 per cent. In other words, a cubic foot of air at 100 deg. is equivalent to 92 per cent. of a cubic foot of air at 60 deg. The power required for compressing a cubic foot of air, once it is in the cylinder, is independent of the temperature of the air. This means that the colder the air is when taken into the cylinder the less will be the number of cubic feet required to give a desired result. For this reason care should be taken to get the air into the cylinder at as low a temperature as possible.

The intake conduit for the compressor should be made of non-conducting material, such as wood, brick or concrete, and should draw air from the coolest place available, never from the compressor room itself. The cross-sectional area of the conduit should be equal to at least one half the area of the piston, in order that the air may flow with perfect freedom. In hot and dusty localities it has been found beneficial to draw air from the interior of a framework covered with burlap or sacking, which is continuously drenched by spray of water. This arrangement not only cools the air but removes the dust at the same time.

If a compressor has poorly designed intake passages, the air as it enters the cylinder may be at a temperature several degrees above that of the atmosphere. The metal of the cylinder becomes quite hot after a compressor has been running for an hour or more, and, after traveling through long and narrow intake-passages the air may be heated to 100°F. or above.

Let Tc = absolute temperature of the air after entering the cylinder, and Ta = atmospheric absolute temperature, then

$$(3) \qquad E_v = E_c \frac{T_a}{T_c}$$

This is the expression for volumetric efficiency modified by clearance and heating of the intake-air.

Leakage past valves and piston will further reduce the intake-capacity of a compressor. If the area of the intake-valves is too small the cylinder will not be filled with air at full atmospheric pressure, and, if the area of the discharge valves is too small, all the air compressed will not be discharged. Poppet valves depend upon a difference in pressure on the two sides of from 3 to 5 oz., for their action and may reduce volumetric efficiency by as much as 2 to 4 per cent. Mechanically operated valves of the Corliss type are very satisfactory, but they must be maintained in correct adjustment.

Though the effect of clearance and of heating the air before compressing can be calculated by the formulas it is well to bear in mind that the results so found may not always agree with the actual conditions of operation. The leakage of air past valves and piston, the choking of air-passages, and bad valve-action, are variables that cannot be determined by formulas. Volumetric efficiency is most accurately determined by measuring the air delivered and comparing it with the displacement of the compressor. Such a method includes all factors affecting the performance of the machine.

When the ratio of compression is large the final temperature of the air in the cylinder may be very high. The relation of temperature to volume and pressure is given in the following equation:

$$(4) \qquad T_2 = T_1 \left(\frac{V_1}{V_2} \right)^{n-1}$$

$$(5) \qquad T_2 = T_1 \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}}$$

The subscripts 1 and 2 indicate initial and final conditions respectively. *P* and *T* are in terms of absolute pressure and temperature. Volumes *V* are in cubic feet. The value of *n* for perfect adiabatic compression is 1.406. For an initial temperature of 60°F., a final gage pressure of 100 lb., and atmospheric pressure of 14.7 lb., the final temperature of the air would be

$$T = (460+60) \left[\frac{14.7+100}{14.7} \right]^{0.29} = 520(7.8)^{0.29} = 931^\circ \text{ abs.} = 471^\circ\text{F.}$$

Should some of the hot compressed air leak back into the cylinder, or should the ratio of compression be increased by throttling of the intake-air through sticking of the valves, the temperature may be even higher than the above theoretical value. That such high temperatures are reached in practice is shown by the explosions that occasionally take place in compressors and receivers.

An air cylinder, unlike a steam cylinder, requires only a small quantity of oil, a drop once in four or five minutes should ordinarily be sufficient. The use of too much oil causes an accumulation of carbon that may choke the valves and passages. Kerosene, often em-

ployed for cleaning valves, has a flash point of 150°F. or less, and ordinary lubricating oils have flash points varying from 330° to 425°F. In view of the high temperatures that may be reached in the cylinder, such oils are obviously a source of danger. Only a thin air cylinder oil, with a flash point of 600° to 630°F. should be used. For cleaning valves, a mixture of soft soap and water should be fed through the lubricating cups once or twice a week. As a safety measure, it is advisable to place a thermometer or fusible plug in the discharge pipe, and as near the compressor as possible.

For pressures up to 60 lb. per sq. in. single-stage compression is satisfactory, but for pressures from 60 to 150 lb., which are commonly used in mining work, two-stage compression is preferable. The ratio of compression in a cylinder of a two-stage compressor is equal to the square root of the ratio of compression in a single-stage compressor delivering air at the same final pressure; consequently losses in capacity due to clearance and leakage are materially lessened. The inter-cooler of a two-stage compressor will reduce the temperature of the heated air from the low-pressure cylinder nearly to that of the atmosphere before it enters the high-pressures cylinder; therefore the final temperature of the air is lower than for single-stage compression, and lubrication is facilitated. However, the sticking of valves, or the choking of passages, may cause such a high temperature to be reached in the high-pressure cylinder that an explosion will occur even in a compound compressor. *Mining Press.* Some liberties taken with the text.

LIQUID FIRE IN THE WAR*

Liquid fire is a weapon of value principally because of its demoralizing effect upon those attacked. There have been some casualties resulting from liquid fire, but it is the psychological effect that is sought. The apparatus usually consists of a metal tank holding about 4 gal. of liquid to be burned, a section of pipe from this tank to a rubber hose at the other end, in which there is a smaller metal pipe about a yard long fitted with a nozzle and a friction igniter, as well as an oil-burning wick. There is a valve near the tank and another near the nozzle. Benzol, from coal tar, and crude oil are used in equal proportions and are carried in the tank under a pressure of approximately 300 lb. per sq. in., this pressure being maintained by compressed nitrogen, an inert gas having no effect upon the contents of the tank. The tank and accessories are carried by one man, while the nozzle is carried by a companion when liquid is being burned. Or it may be fixed in position and operated by the same man who carries the tank.

In use a cap is drawn from the end of the nozzle and a wick burning kerosene or similar oil is thereby lighted, since the cap is a friction igniter. The oil is then turned on and is ignited as it leaves the nozzle under great pressure. The result is a flame of burning oil about 30 yd. long. For two-thirds of this distance the flame is straight, but it then turns up as does any other flame. It may be directed against the ground, but care must be taken not to deflect it too sharply as it may strike the ground and turn back towards those operating the device. It is therefore not well suited to turning down into a trench.

It is said by an expert that liquid fire is not so effective now that it is understood by the troops and means for defense have been worked out. It can be readily understood, however, that a number of such devices, with the roar of the escaping oil, when used together, gave a means of demoralizing the defenders of a trench, especially at night, and in the beginning was a valuable accessory, especially by raiding parties.

*Bulletin of American Chemical Society.

The range of complete combustion of mixtures of gasoline vapor and air is very narrow, according to an investigation made by the Bureau of Mines, which showed that it was limited to mixtures containing only between 1.5 and 2.5 per cent. The amount of carbon dioxide produced reaches a maximum at 2.5 per cent. of gasoline vapor. At this point, as the percentage of gasoline vapor increases, carbon monoxide begins to form. At 4.1 per cent. of gasoline vapor there is produced 14.0 per cent. of carbon monoxide.

The construction of a railroad tunnel 13 miles long through the Hindu Kush mountains between Turkestan and India is being considered.

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CONTENTS

RUSH THE AIRPLANES

The present month sees the completion of the third year of the world's life-and-death struggle, and the occasion suggests inquiry as to the outlook. We may believe that we are nearer the end than we were at the beginning, but how much nearer no man may say. We of the United States, compelled to shoulder our share of it, are proceeding with our preparations in a way which seems to be characterized by anything but haste. There may be magnitude of plan which is not incommensurate, but when is telling effectiveness to be reached at the rate we are going.

The futility of much of our most demonstrative preparation is too evident. It seems to be now universally, if only tacitly, conceded that masses of men backed by inexhaustible munitions, although they must have their weight, are not to be the determining factors. The art of war has been transformed, and the new devices which have demonstrated their superiority in strategic facility and in ultimate destructiveness, which is the test of war efficiency, are our present hope for the closing of the wretched business.

It seems to be for the submarine and the airplane to bring the fight to a finish. The toll the submarine is taking is not to be too lightly spoken of, but it suggests no finality. It seems to be adapted only to the purposes of the central powers, and the allies have no use for it as there is no commerce for them to destroy. The possibilities of submarine destructiveness may be said to be quite fully revealed and the means of thwarting it seem to be rapidly developing, but we have as yet no hint of the unlimited resources of achievement the airplane commands. It is a most invaluable and now an absolutely necessary adjunct to both the army and the navy, whether for offensive or defensive operations, and is in itself an independently operating aggressive force with an unlimited field all its own.

The airplane, unlike the submarine, is equally adapted to the purposes of both the opposingforces and can be used with equal success by either side, so that we may be quite certain that the central powers will be rushing the fliers out and employing them by wholesale in their unlimited schemes of frightfulness, and it is up to us to concentrate our resources of production to meet the supreme emergency.

letting this take precedence over all else. Twenty thousand air planes and a hundred thousand aviators is not an extravagant estimate for our quota of the immediate requirement, these to be followed by the improved apparatus which will inevitably be developing as long as the agony continues.

The airplane, which must be by this time sufficiently standardized, is of a character almost ideal for rapid reproduction under American manufacturing systems. The machine in detail consists of small parts quickly produced and easily handled, and these could be distributed among a hundred establishments ready equipped with tools easily adaptable to the special requirements.

The assembling and the trying and adjusting could go along quite as rapidly as the aviators could be trained to use them. It is for the nation to show what it can do in this line, and especially how quickly it can do it.

TUNNELS AND MORE TUNNELS FOR GREATER NEW YORK

BY JOHN F. O'ROURKE

For more than forty years I have watched with keen interest the building and development of the great Port of New York, having been connected with its bridges, buildings, streets and rapid-transit roads all that time, both as engineer and contractor. In all these years it has been a sort of hobby with me to forward the interests of Manhattan, and I am grateful for the fact that my part, however modest, was that of being a part and parcel in the participation in its growth. The building of the great Pennsylvania tunnels by my company across the North River, which bring hundreds of thousands of people daily into New York without causing any congestion or interruption of traffic, is one of the great things which have happened to the city. I cite the Pennsylvania tunnels as an example. The plans by which they were built have been followed by other engineers in the construction of tunnels since.

SAFETY OF TUNNEL BUILDING

The building of tunnels in the twentieth century is safe, as far as life is concerned, there being much less risk for a tunnel worker than there would for one performing labor on a skyscraper. In fact, to my way of thinking, the danger to life is far more hazardous working on structures reaching skyward.

The most essential point in the building of tunnels is to safeguard the overhead property, such as the streets, houses, and buildings. The method of filling the spaces outside tunnels which are left by the shields as they move forward along the tunnels which are built inside their tails leaves no spaces in which a settlement can occur. The recent tunnels built for the Public Service Commission under the East River and adjoining streets have been built by this method without any sign on the surface of their construction and existence, nor have either the residents or the public had any knowledge of the work below from anything that could be seen by them. There is not a break or a sign of any outward disturbances or any undermining of buildings, or, as a matter of fact, no one, even if one had a technical knowledge of engineering, could realize that one hundred feet or more below a great work was going on in the building of a tunnel.

These are days of great opportunity for New York; I, for one, look for all of us to keep our heads and demonstrate our capacity and fearlessness in pushing forward, not alone in tunnel-building, but in all kinds of development and improvement, thus aiding and contributing to keep New York the great port, and adding to and making it all the time a greater one, with more docks, more railways, that will add greatly to the number and convenience of our citizens and the further development along lines for capacity, economy, and efficiency of our port, thus helping materially to maintain its supremacy over the other ports of the world.

MORE AND GREATER TUNNELS

Among other things, I look for tunnels that will connect Staten Island to New York, both for railways and automobiles; also to New Jersey. Then there would be built tunnels exclusively for automobile traffic under congested streets, as outlined in the New York *Evening Post* with reference to Fifth avenue in one of its recent issues. I wish also to state my belief that the engineering of what might be termed municipal facilities, such as streets, docks, and tunnels, is still in its infancy, and far greater accomplishments are yet in store. For the present, as stated in the beginning of this article, there is a new method by which

subways and tunnels may be built without the usual penalties of destruction of business and comfort along the line. The solution of the problem of absolute safety to streets and property overhead is the keynote to modern tunnel engineering.

CHEAPNESS OF CONSTRUCTION

The great point in connection with this is the saving of expense in preventing damage to buildings or interference with the use of the streets by either tenants or the public. By the method of "gravel packing," a shield-driven tunnel connecting Staten Island with New York, consisting of four racks for railways or automobiles, could be constructed at a cost much less than that at which two single-way tunnels could be built by any other method of tunnel construction.

Thus the introduction of multiple way tunnels brings in a new era in municipal engineering, because it multiplies their capacity and reduces their cost. Another vital point in my plan for tunnel construction is the great saving of time and cost brought about by this up-to-date method and employment of powerful machinery and thoroughly efficient methods of procedure. Our one aim should be to concentrate all forces to make the Greater Port of New York the leading port of the world. —*Evening Post*, New York.

ABOUT ATMOSPHERIC HUMIDITY

BY B. V. R. GAGE

The instrument in the weather bureau kiosk marked "relative humidity" is supposed to show the percentage, by weight, of water vapor in the air, 100 per cent. being when the atmosphere can hold no more in the form of steam. The maximum weight of steam that the atmosphere is capable of holding is dependent on, and increases with an increase of, the temperature. The action of this hygrometer depends on the expansion and contraction in length of a hair or fiber as it increases or decreases in moisture content.

Another common device for measuring the relative humidity is a combination consisting of two ordinary thermometers, one having the bulb covered with a wet cloth or a wick extending into a vessel of water. In the use of this instrument the wet-bulb and the dry-bulb temperatures are taken. If they are the same, the humidity is 100 per cent., but when there is a difference it is necessary to consult tables in order to obtain the relative humidity. The engineer generally uses a "sling psychrometer," which is essentially a "wet and dry bulb" outfit so mounted that it can be rapidly revolved. The readings are the same as with the stationary type, but a table of different numerical values must be employed.

DETERMINING RELATIVE HUMIDITY

The most accurate and also the most logical method of determining relative humidity is the dew-point apparatus. With this a surface is cooled until moisture is condensed from the air. The temperature at which condensation begins is the boiling point corresponding to the actual vapor pressure of the H_2O in the surrounding space. The corresponding pressure may be found from steam tables, using the dew-point temperature; the difference between the actual air temperature and the dew-point temperature gives the degree of superheat. Consulting a steam table, the weight per cubic foot of superheated steam under these conditions may be found; call this *M act.* Then look up the weight per cubic foot of dry and saturated steam at the air temperature and call this *M sat.* The relative humidity is *M act* ÷ *M sat.*

In order to understand about this matter of humidity, let us consider a few things to which perhaps we have never given much attention.

Water in a teakettle on a hot stove first boils, a part of it turns to steam and drives all the air out of the kettle. In the teakettle there is then only H_2O in the liquid and gaseous states. The steam has nearly free access to the air, so the pressure inside the kettle is not much greater than atmospheric. That means that the vapor pressure in the kettle is about 14.7 lb. per sq. in. abs., with a corresponding boiling point of about 212 deg. F. So far we have considered only equilibrium between two phases, in which the vapor phase is maintained free from other gases and atmospheric pressure is maintained in the vapor space. As the steam leaves the kettle, other things happen. The vapor is separated from contact with the liquid, the total pressure in space remains the same, and the steam mixes with other gases of a lower temperature. Right here remember that steam is invisible, that what we see is the result of light reflection from minute drops of water in the steam.

ANOTHER EXAMPLE

Now let the teakettle go for a time and take up another homely matter—what happens to the clothes on wash day. They are hung out to dry, the water which they contain evaporates and goes off into the air as invisible steam. The temperature of this water never reaches 212 deg.; in fact, during the winter, the clothes freeze solid and stay below 32 deg. until they are dry. The water has changed from ice to steam and yet has never gone above the freezing point. A consideration of the molecules may help toward an understanding of what happens. Put a pan of water in a closed vessel, the whole to be kept at a constant temperature. For the purpose of this example it makes no difference what the pressure is; it can be a vacuum, atmospheric or several atmospheres, without appreciably altering the results. After some time has elapsed, the space inside the vessel becomes saturated with water vapor, humidity 100 per cent. H_2O; the pressure corresponds to the temperature with dry and saturated vapor.

MOLECULE ACTION

Another homely example of this type is the use of a closed vessel to keep bread from drying. Now the water consists of molecules in magnitude somewhat similar to the particles of dust of the earth's surface. For the given temperature we can know the average kinetic energy of each molecule, but actually we cannot know the velocity of a given molecule at a given time. It is like the life-insurance business. The actuaries can take a large group of men and tell how many will die at 40 years old, how many at 45, etc., but they cannot tell at what age a particular man will die. Some of the molecules have a much greater velocity for an instant and at times shoot through the surface of the liquid and get to wandering around in the space above. When enough of these molecules are in the space above so that there are just as many going back into the liquid as there are coming out, then the condition of equilibrium is established between the liquid and the vapor phases for that temperature, or in other words, we have the vapor pressure for that temperature. If the space is not inclosed, some of the molecules can escape, but nature tries to build up and maintain such equilibrium.

In the case cited the temperature was to be maintained constant. If the water vapor can escape from immediate contact with the liquid, so that the vapor pressure cannot rise to the value corresponding to the saturated condition, and if heat is not supplied, then the temperature will be lowered. The molecules with the greatest energy escape, thus lowering the average energy of the mass of molecules. This loss of energy is shown by decrease of temperature; witness, the porous earthenware jugs used to cool drinking water.

DIFFERENT GASES IN THE SAME SPACE

In thinking of this phenomenon, it is best to consider the atmosphere not as air, but as space. The air is made up mainly of nitrogen, oxygen and water vapor. If a cubic foot of air be taken, each gas will be found in every portion of it. That is, each one occupies the whole space. The total pressure exerted will be about 14.7 lb. per sq. in. and is the sum of the partial pressures of each one of the constituents. If any one of the components is to be placed under 14.7 lb. pressure, it will be necessary to compress it into a much smaller volume. If possible to separate the gases, each might be compressed to 14.7 lb. and then the sum of the volumes would be one cubic foot, the same as in the first place. Each gas which makes up air may be treated as though the others were not present, provided the total volume and the partial pressure are used.

Fog is caused by reducing the temperature of the air below the boiling point corresponding to the vapor pressure. In case of fog, the humidity may be said to be greater than 100 per cent., although there are some serious objections to such a usage. When there is fog, the water vapor in the air is in the form of wet steam. At 100 per cent. humidity the form is dry and saturated vapor; at less humidity, it is super-heated steam.

On a foggy day the humidity in the boiler room is generally less than 100 per cent. As the wet steam enters the room, it receives sufficient heat to evaporate the water and then to superheat the steam. More weight of vapor can be held in unit volume when the temperature (and hence vapor pressure) is higher.

The loss of heat in boiler operation due to humidity is negligible. In the first place the weight of the water vapor is relatively very small. And then the heat loss per pound of vapor is the product of the specific heat of steam and the increase of temperature from the room to the flue. The specific heat value

is about 0.45 for usual humidity conditions and, $Loss = WC\ (tf - ta)$.

The heat loss due to the combustion of the hydrogen in the volatile matter is the sum of a portion of the heat of the liquid, all the latent heat and some heat of superheat. Represent weight of water by W, heat of liquid by q, heat of vaporization by r, temperature by t, specific heat by C; subscripts $a =$ air, $f =$ flue, $h =$ vapor pressure, $212 =$ atmospheric pressure. The foregoing statement then is shown by

$$W[q_h + r_h + C\ (t_f - t_h)]$$

(If q_h is corrected to fuel temperature it may become negative) and a commonly used expression,

$$W[(212 - t_a) + r_{212} + C\ (t_f - 212)]$$

is not correct.

Inspection of a B.t.u-entropy chart for steam shows that the total heat of one pound of dry saturated or superheated steam, for pressures less than 3 lb. per sq. in abs., is practically a function of the temperature and independent of the pressure. The vapor pressure in the air or flue gas can hardly reach 3 lb. So the following formula* is true:

$$Loss = W\ (1090.7 + 0.455t_f - t_a)$$

A consideration of the heat loss due to combustion of hydrogen opens the question of higher and lower heating values. The former is obtained when the water thus formed is all condensed and cooled to the original temperature of the fuel, along with all the other products of combustion. A lower heating value is obtained when the water is only partly condensed or not condensed at all, or when the products of combustion are not cooled to the original temperature, or by a combination of uncondensed water and insufficient cooling. There are an infinite number of lower heating values for any fuel containing hydrogen. When the term lower heating value is used, it is necessary to inquire under what conditions it was determined. In order to make an experimental determination of the higher heating value, it is necessary to have the air and the fuel supplied for combustion at 100 per cent. humidity and at standard temperature, to have the products of combustion cooled to this same temperature and humidity, to separate out all drops of water, and to have the products of combustion occupy the same volume as the elements and at the same pressure. It is not hard to recognize the difficulties of this task. So we do the best we can and make corrections when necessary.

*"Experimental Engineering," Carpenter and Diedricks, p. 467.

From the preceding facts regarding the action of the water molecules, it is evident that the water in an exploding boiler will tend to expand to the vapor pressure in the surrounding space. What this vapor pressure will be depends upon many factors, including the rate of removal of water vapor, the temperature, etc. It certainly is not correct to assume 14.7 lb. and 212 deg. without proof. And proof is impossible. The vapor pressure may be either greater or less than 14.7 lb. Then there is the other factor of violent actions tending to go through equilibrium to the opposite extreme.

History furnishes examples of peoples awfully oppressed, revolting, and when liberty is gained temporarily turning it into license. A more technical example is a compressed spring; when the load is suddenly removed, the spring extends nearly as far as it had previously been compressed. There is no telling how gradually the pressure is relieved from the water in the exploding boiler, as it will build up vapor pressure in the immediate vicinity, set up waves of high and low pressures and otherwise introduce various conditions.—*Power.*

A MINING DRILLING CONTEST

For many years in some of the important mining centers of the West hand drilling contests have been a feature of the Fourth of July doings, and the results of some of these contests have been recorded in previous volumes of Compressed Air Magazine. This year at Tonopah, Nevada, a so-called Jackhammer contest was held. This designation of the drills as a class was of course incorrect, as the name "Jackhamer" is a copyrighted trademark of a single company and applies only to the drills of its manufacture.

In this event there were forty-two contestants, including among them representatives of all the manufacturers of unmounted, self-rotating hammer drills. The true Jackhamer (Type B C R-430) won first, third and fourth places, and the Sullivan Rotator (Type D P-33) won second place. The drilling was in Rocklin granite, each contestant being allowed eight

minutes in which to connect his hose and drill as great a footage as possible.

The winning Jackhamer drilled 61 7-16 inches in the time, and the Rotator which took second place drilled 58 7-8 inches.

NOTES

The article upon page 8403 of Compressed Air Magazine, June, 1917, entitled "Two Baby Hoists Run a Disabled Derrick" was reproduced without change from Engineering Record, March 10, 1917. We much regret that thankful acknowledgement was not made at the time of our republication.

Andrew Lemon, an oil well shooter, and Fred Baker, oil field worker of Okmulgee, were blown to pieces recently when 80 quarts of nitro-glycerin which they were taking to the Baldhill field, were exploded by a jolt to their automobile.

The mints of the United States purchase bullions from all the precious-metal districts. These bullions are sold for their gold and silver contents, but the government makes a neat profit through the recovery of various other precious metals, such as palladium and iridium.

Rio Tinto, the oldest copper mine in the world, once worked by the Romans, and before them by the Phoenicians paid to its British owners last year the sum of $10,500,000. That represents an earning capacity of 95 per cent. on the capitalization of the company.

It would seem the wiser policy to leave the adoption of the metric system optional, as we and our American cousins have done hitherto, till the civilized nations have agreed upon a really correct unit. Anyone who travels in the countries where the metric system is in force knows that in common practice it is not universally adhered to, but that the old measures and weights are still used by the masses.—*The Engineer*, London.

Something like 500,000,000 rabbit skins are imported into this country yearly, principally for the manufacture of felt hats. A fair grade of fur from Australian rabbit skins has a value of from $2.50 to 5 lb. The fur is skilfully shaved off the skins; during this process the skins are shredded so as to present an appearance not unlike excelsior packing. Glue produced from these skins is remarkable for its elasticity—freedom from mold and odor—and for lining oil barrels is superior to any other material available.

German experiments in the use of acetylene gas in internal combustion engines show that the proportion of air to gas to avoid sooting should be as 12.02 is to 1. The maximum compression for the mixture is about three atmospheres. One ton of carbide is sufficient to produce 10,000 cubic feet of acetylene.

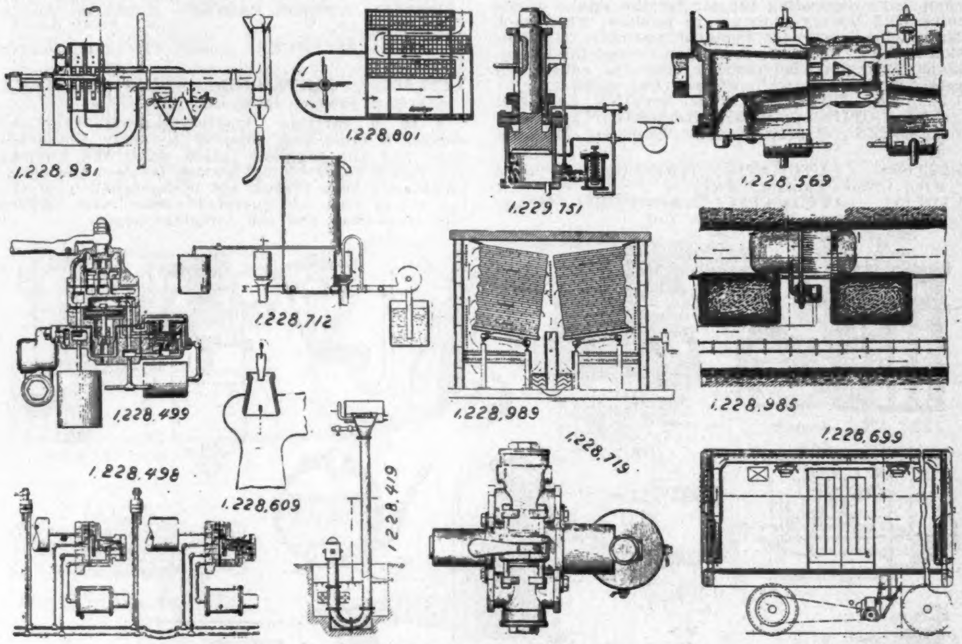
A simple high vacuum pump, recently developed at the United States Bureau of Standards, can be built entirely of glass by a reasonably skillful glass blower and requires for its operation only a bunsen burner and a water aspirator. The remarkable feature of this exhauster is that it is capable of giving vacua down to better than 0.001 mm. pressure.—*Commerce Reports.*

The gross total of motor cars, including commercial cars, registered in 1916 was 3,512,916, according to figures compiled by the U. S. Office of Public Roads. This is an increase of 1,067,332 over the number registered in 1915. The several states collected in registration and license fees, including those of chauffeurs and operators, a total gross revenue of $25,865,369. Of this amount 92 per cent, or $23,910,811, was applied directly to construction, improvement, or maintenance of the public roads in 43 states.

There probably was never a time in the history of the mining industry when so many sound, solid, well-managed and dividend-paying concerns presented themselves to the public. During the last 30 years mining has enormously expanded, and has emerged largely, we had almost said entirely, from the category of speculation, and reached the status of an industry. Instead of being regarded as a neck-or-nothing venture—a sort of horse-race gamble—mining to-day presents itself with credentials of stability and success which cannot be denied.—*Mining World*, London.

To completely extinguish mine fires not only must the flames be put out, but the heat must be dissipated. This is the harder part of the

work. The temperature may long remain so high that when air is supplied the fire will break out again. Speaking at meeting of the Manchester Geological and Mining Society, A. Stoker declared that a fire that had been stopped off for 28 years, and had died out for lack of oxygen, broke out again in several local conflagrations when supplied with air, which is a strong argument in favor of water quenching as against gas quenching.



PNEUMATIC PATENTS JUNE 5

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 5

1,228,419. PRESSURE CONTROL IN PUMPING. George H. Eckert, Syracuse, N. Y.

1. The method which consists in reciprocating a column of liquid with a velocity sufficiently limited to preserve the coherence of the column and having sufficient bulk and path of travel to acquire useful momentum, utilizing an expansive force to cause one stroke of said reciprocation, and restraining a return stroke by a below atmospheric pressure to the rear of the column in order to reduce the pressure developed.

1,228,498. STRAIGHT-AIR EMERGENCY-BRAKE. Walter V. Turner, Edgewood, Pa.

1,228,499-50. ENGINEER'S BRAKE - VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,228,569. CAR AND AIR-HOSE COUPLING. William S. Knisely, Benton Harbor, Mich.

1,228,608. FLUID-OPERATED EJECTOR. Arthur Edwin Leigh Scanes, Ashton-upon-Mersey, England.

1,228,640. APPARATUS FOR PREPARING FOOD. John D. Belton, Crowley, La.

1. In a device of the class described, a heating and mixing chamber, the former communicating with the latter, heated rollers in said heating chamber, a belt conveyer on said rollers, a spiral conveyer in said mixing chamber, an aspirator chamber communicating with said mixing chamber, a spiral drum in said aspirator, means for rotating said conveyer and drum, and means for creating air currents in said aspirator, substantially as described.

1,228,699. APPARATUS FOR MAINTAINING A UNIFORM TEMPERATURE IN RAILWAY FREIGHT-VANS. Arthur William Prim, Liverpool, and Francis William Roper, Sheffield, England.

A self contained freight car having air casings for the circulation of air within the car so that it passes through the freight contained therein, means located at the end of the car for heating the air as it circulates, fans for circulating the air through the air casings, adjustable means located at the ends of the car and communicating with the atmosphere for ventilating the car, valved air ports communicating with the atmosphere at the ends of the car and in proximity to said heating means, whereby the car may be completely closed and circulation of the heated air effected therein, or it may be ventilated through openings to the outside air.

1,228,712. APPARATUS FOR STERILIZATION OF LIQUIDS BY OZONE. Jan Steynis, Bay Shore, N. Y.

1,228,719. ELECTROPNEUMATIC TRIPLE - VALVE MECHANISM FOR COUPLING SYSTEMS. Charles H. Tomlinson, Mansfield, Ohio.

1,228,801. APPARATUS FOR MOISTENING AIR. Frank W. Masek, Cleveland, Ohio.

1,228,914. APPARATUS FOR RAISING SUNKEN SHIPS. Eugene S. Hayford, New Orleans, La.

1. An apparatus for raising sunken ships, including a collapsible and inflatable envelop, means

for supplying air thereto, and an auxiliary inflatable envelop mounted therein and constituting a buoyant support for the main envelop.

1,228,931. VENTILATING APPARATUS. Jason E. Kirk, Christiansburg, Va.

1,228,985. MEANS FOR PREVENTING EXPLOSIONS IN MINES. Audley Hart Stow, Maybeury, W. Va.

1. A method of preventing explosions in mines comprising saturating the air for the intake of the mine with watery moisture to produce, when such air reaches the cooler spaces of the mine, a condition of fog by moisture deposition around the bituminous dust particles causing them to adhere together and to the walls of the mine spaces.

1,228,989. DRY-KILN FOR DRYING LUMBER AND OTHER MOISTURE-BEARING SUBSTANCES. Harry Donald Tiemann, Madison, Wis.

1,229,039. AUTOMATIC TIRE-PUMP. Leslie Fred Crane, Lansing, Mich.

1,229,151. AUTOMATIC TRAIN-STOP. Hiram Gee Sedgwick, Mill Valley, Cal.

whereby the oil will be vaporized and thoroughly mixed with the heated air, and combustion in the vaporizing chamber will be prevented.

1,229,344. PNEUMATIC SPRAYER. Howard L. Stevens, Everett, Wash.

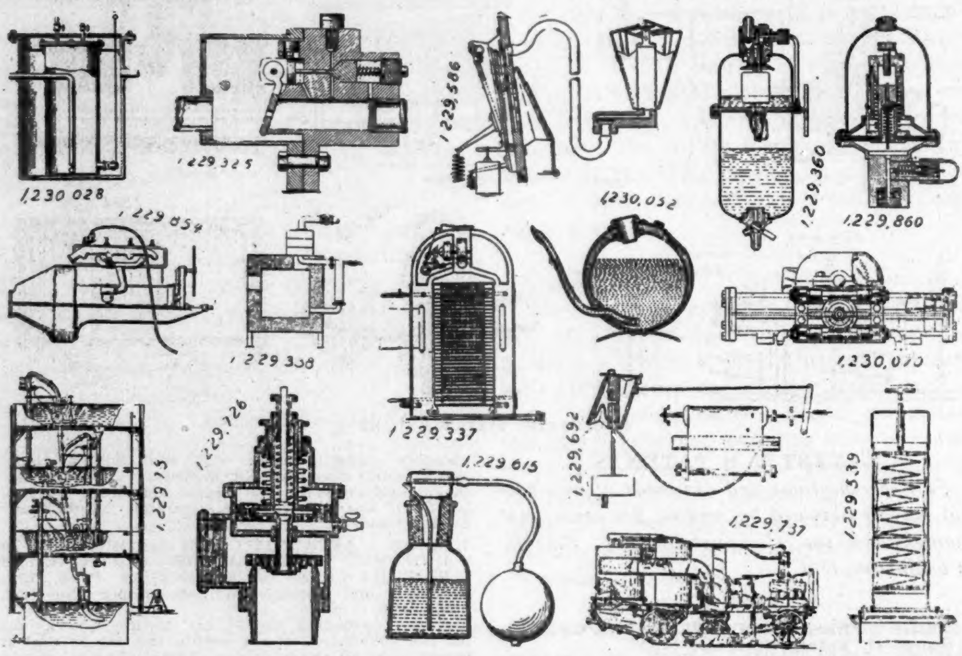
1,229,360. VACUUM FEED SYSTEM. Frederick Weinberg, Detroit, Mich.

1,229,397. PROCESS AND APPARATUS FOR DRYING EDIBLE PASTES. Albert M. Austin, Piermont, N. Y.

1,229,434. SILENCER. James Flockhart, Denver, Colo.

1,229,467. CARTRIDGE-LOADING MACHINE. Clarence Eugene Jack, Louviers, Colo.

1. In a cartridge loading machine, tamping means, a cross-head adapted to carry the same, head and the tamping means when the tamping and means for avoiding friction between the cross-means has been thrown out of operation, comprising compressed air operated connections between the cross-head and the tamping means.



PNEUMATIC PATENTS JUNE 12

In an automatic train stop, a brake controlling means on the locomotive, a pneumatic motor for operating the same and means for connecting the motor to a storage reservoir, means for governing the supply to the motor to cause the same to operate and apply the brakes, means for restoring the motor to operative position, these means embodying a cut off automatically opened and closed by the action of the motor.

JUNE 12

1,229,276. THROTTLE-VALVE FOR PNEUMATIC TOOLS. Francis A. Jimerson, Athens, Pa.

1,229,325. SAFETY-VALVE FOR AIR-BRAKES. Michael H. Ryan, San Bernardino, Cal.

1,229,338. METHOD OF PRODUCING FUEL-GAS. Max Sklovsky, Moline, Ill.

1. The method of producing a gaseous fuel for heating furnaces, which consists in preheating air to a temperature high enough to substantially wholly vaporize fuel oil, passing the air so heated through a vaporizing chamber at high velocity, and introducing fuel oil into the stream of air flowing continuously through said vaporizing chamber,

1,229,501. PNEUMATIC PLAYER-ACTION. Frank E. Nichols, Mount Carmel, and Earl W. Feltis, Norwood, Ohio.

1,229,539. BLOWER FOR CLEANING FURNACE-FLUES. Walter P. Sparboom, Rochester, N. Y.

1,229,543. SYSTEM AND APPARATUS FOR CONTROLLING FLUID-MOTORS. Norman W. Storer, Pittsburgh, and Arthur J. Hall, Wilkinsburg, Pa.

1,229,586. AIR-MOTOR-GOVERNING DEVICE. Melville Clark, Chicago, Ill.

1,229,587. INSTRUMENT FOR RECORDING PERCENTAGE VOLUMES OF CONSTITUENT GASES. Walter William Crosweller, Crumpsall, Manchester, England.

1,229,615. ATOMIZER. James J. Holland, Philadelphia, Pa.

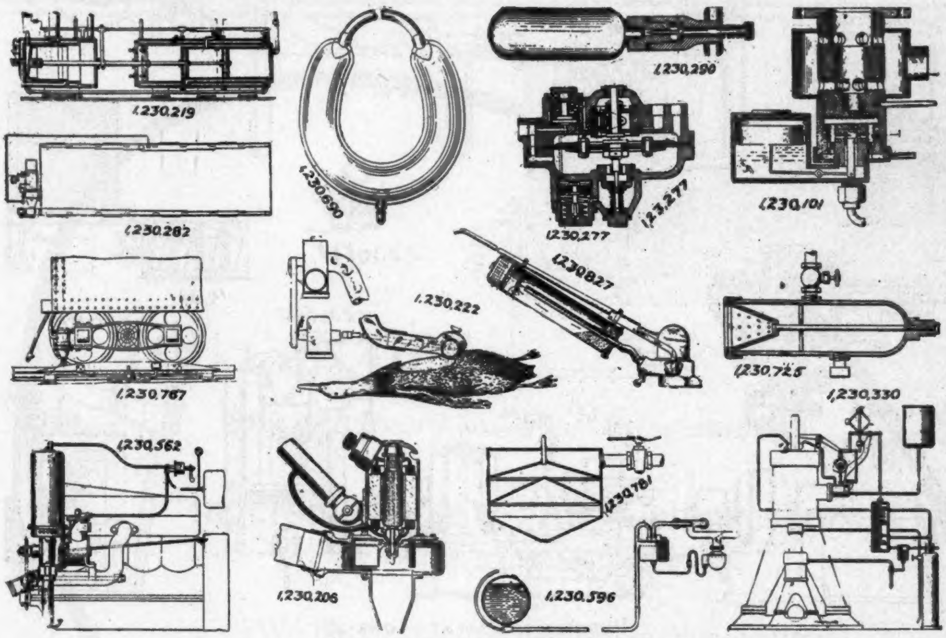
1,229,692. PNEUMATIC NOTE-SHEET-TRACKING DEVICE. Frank C. White, Meriden, Conn.

1,229,713. MECHANICAL AIR-BORNE SHIP. George Albert Chaddock, Broad Green, Liverpool, England.

1,229,726. SAFETY AIR-RELIEF VALVE. Frederick William Ebeling, Hoboken, N. J.
1,229,737-8. PNEUMATIC STREET-CLEANER. Robert W. Furnas, Indianapolis, Ind.; Frank A. Hamilton and Leila F. Hamilton executors of said Robert W. Furnas, deceased.
1,229,781. LIQUID - ELEVATING APPARATUS. Eugene O'Sullivan, South Bethlehem, Pa.
1,229,792. AUTOMATIC CONTROL MEANS FOR AIR-PRESSURE PUMPS. Harvey J. Russell, North Bend, Oreg.
1,229,854. TIRE-PUMP. John W. Aker, Lancaster, Ky.
1,229,860. AIR-VALVE. Hervey Bowes Ashelman and John Sandford Johnson, Fargo, N. D.
1,230,028. PNEUMATIC PUMP. Edward E. Rardon, Hamilton, Kans.
1,230,052. VISCOUS-FLUID APPLIER. Lemuel Lester Stevenson, Emporia, Kans.
1,230,070. MOTOR FOR FLUID-PRESSURE DOOR-OPERATING DEVICES. Albert Gottschalk, New York, N. Y.
1,230,277. PNEUMATIC BRAKE. Francois Jules Chapsal, Paris, and Alfred Louis Emile Saillot, LaGarenne-Colombes, France.
1,230,282. DRYING APPARATUS. Charles H. Currier, Newark, N. J.

1. In apparatus of the class described, a kiln, inlet and outlet air ducts therefor located on opposite sides thereof, both sets of ducts opening downwardly toward the floor of the kiln, and means for supplying conditioned air under pressure to the inlet ducts.

1,230,290. LIFE-PRESERVER. Bertha A. Geiger, Chicago, Ill.
1,230,330. AIR-SUPPLY SYSTEM FOR COMBUSTION-ENGINES. Robert Schlaepfer, Winterthur, Switzerland.
1,230,549. PNEUMATIC ACTION FOR PLAYER-PIANO MECHANISM. Aura E. Whitehead, Chicago, Ill.
1,230,562. COMPRESSED-AIR STARTER FOR INTERNAL-COMBUSTION ENGINES. Niels Anton Christensen, Milwaukee, Wis.



PNEUMATIC PATENTS JUNE 19

1,230,071. PNEUMATIC-TIRE-ALARM DEVICE. Lewis E. Hawk, Chicago, Ill.
1,230,083. ELECTROPNEUMATIC VALVE FOR AIR-BRAKES. Thomas W. Scott, Baltimore, Md.

JUNE 19

1,230,101. PROCESS OF CARBURETING AIR. Turner D. Bottome, Indianapolis, Ind.
1,230,206. SUCTION-PRODUCER. Henry C. Niemeyer, Racine, Wis.
1,230,219. AIR-COMPRESSOR AND MOTOR. Arthur Reall, Philadelphia, Pa.

1. In an apparatus of the character described, the combination of a plurality of cylinders, pistons in said cylinders, means for driving the said pistons in one direction to compress air in one or more of said cylinders, means for conducting a portion of the air so compressed to a point outside of said cylinders, and means whereby a portion of the compressed air is permitted to act upon one or more of said pistons to drive the same in the opposite direction.

1,230,222. FEATHER-PICKING MACHINE. Otto G. Rieske, Toronto, Ontario, Canada.
1,230,596. LIQUID-FEED SYSTEM. Charles L. Stokes, Los Angeles, Cal.
1,230,690. PNEUMATIC CUSHION. Anton C. Eggers, Brooklyn, N. Y.
1,230,725. OIL-BURNER. Jacob F. Kraus, Pittsburgh, Pa.
1,230,767. AIR-BRAKE STOP. Eskil V. Palmquist, Hallandale, and Henry G. Lundquist, Seminole county, Fla.
1,230,781. AIR-FEED FOR MOTORS. Samuel E. Reid, Tahoka, Tex.
1,230,802. PNEUMATIC HAMMER. Frank J. Schroeder, Altoona, Pa.
1,230,827. VACUUM CLEANING APPARATUS. John J. Duffie, San Francisco, Cal.
1,230,832. VACUUM LIQUID - FEEDING APPARATUS AND METHOD THEREFOR. Charles Lawrence Stokes, Millong, via Young, New South Wales, Australia.

JUNE 26

1,230,834. MECHANISM FOR UNLOADING COMPRESSORS FOR STARTING. Burton S. Aikman, Milwaukee, Wis.

1,230,843. FOWL-DISINFECTANT APPARATUS. David B. Bird, Chicago, Ill.

1. A lever, resilient means supporting the lever in pre-determined initial position, a perch on the lever, a spraying device adjacent the perch for action upon a fowl when on the perch, a blowing device constructed to be actuated by said lever, duct connections between the blowing device and the spraying device, and operative connections between said lever and the blowing device, whereby the weight of a fowl on the lever will operate the blower for the purposes described.

1,230,858. APPARATUS FOR INFLATING LIFE-PRESERVING BELTS. William Gould Brokaw, Paris, France.

1. In apparatus for inflating life-preserving belts, a gas cartridge, a holder for said cartridge secured to the wall of an inflatable life belt, a gas release valve carried by said holder, a diaphragm fixed to said holder, a pin on the inner side of said diaphragm adapted to actuate said valve, a plate at the outer side of said diaphragm, a fulcrum for said plate fixed to said holder, an operating lever mounted in said holder adopted to turn said plate about said fulcrum in a direction to move said diaphragm inwardly and operate said valve.

1,230,925. MECHANISM FOR UNLOADING COMPRESSORS FOR STARTING. Walter J. Richards, Milwaukee, Wis.

1,230,949. VARIABLE-LOAD BRAKE. Walter V. Turner, Edgewood, Pa., and Edward H. Dewson, New York, N. Y.

1,230,951-2. FLUID - PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.

1,230,953. RELEASE-VALVE FOR VACUUM-BRAKES. Walter V. Turner, Wilkinsburg, Pa.

1,230,995. AIR-MOTOR. Melville Clark, Chicago, Ill.

1,231,051. COMPRESSED-AIR POWER SYSTEM. Bruno V. Nordberg, Milwaukee, Wis.

1. In a compressed air power system the combination with a compressed air engine of an air compressor, an air receiver connected with the discharge of the compressor and having a manually controlled connection with the engine, and an open water tank located above and having a constantly open and unobstructed connection with the air receiver, said receiver and tank being so constructed, arranged and connected that a quantity of compressed air equal to the entire volume of the receiver may be drawn therefrom at an approximately constant pressure.

1,231,077. VACUUM-CLEANER. Ira L. Sheffler, Detroit, Mich.

1,231,081-2. AIR-BRAKE SYSTEM. Jacob Rush Snyder, Pittsburgh, Pa.

1,231,212. ELECTROPNEUMATIC ORGAN. Fredrick W. Smith, North Tonowanda, N. Y.

1,231,214. TRIPLE VALVE. Jacob Rush Snyder, Pittsburgh, Pa.

1,231,360. PNEUMATIC FILM-CONTROLLING DEVICE. Albert S. Howell, Chicago, Ill.

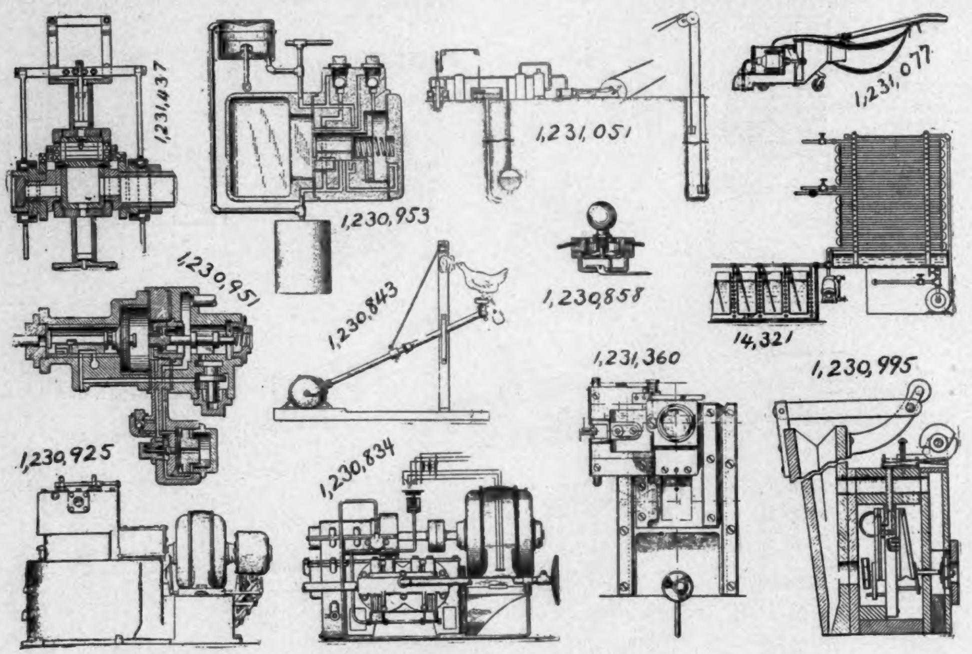
1. In apparatus for moving film, an aperture element, a passage through which the film is adapted to travel past said aperture, and means for exerting pneumatic pressure upon the film during transit through said passage.

1,231,437. ROTARY ELASTIC-FLUID ENGINE. William Herbert Seddon, Painswick, England.

1,231,515. DRY-PIPE VALVE. Poul Flamand, Philadelphia, Pa.

14,321. PROCESS OF AGITATING WATER IN MAKING ICE. Willis B. Kirkpatrick, Baltimore, Md.

1. A process of agitating water by air in the manufacture of ice which consists in providing a supply of de-hydrated air at a pressure of from twelve to twenty-five pounds above atmosphere, passing said air through a conduit within the mass of water to be frozen, reducing the pressure of the air before it is released to a point slightly in excess of that of the atmosphere, and delivering said air into the water near the bottom of the mass.



PNEUMATIC PATENTS JUNE 26